Rio Tinto Alcan

Annual environmental report

B.C. Operations

2011

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Main entrance, Kitimat Operations

About this Report

Chapter 1

In 1999, Rio Tinto Alcan's Kitimat Operations became the first industrial facility in British Columbia to obtain a multi-media environmental permit from the provincial government. This permit comprehensively addresses multiple emissions, effluents and solid waste, sets limits and establishes monitoring and reporting requirements. The multi-media permit replaced a number of previous permits and is a key regulatory compliance benchmark for smelter operations.

The permit provides guidelines for a results-oriented environmental management approach. Kitimat Operations combines the permit guidelines with other proactive strategies to facilitate vigilant compliance monitoring and regular communications with public and private stakeholders.

The multi-media permit mandates annual reporting to measure performance against established permit standards. This Annual Environmental Report is provided to meet the reporting requirements under the permit. It is submitted to the provincial government and made available to the public.

In addition to the permit reporting for Kitimat Operations, a summary report for compliance of the Kemano Operations environmental permits is provided.

In 2011, there were nine non-compliances; two related to emissions, one related to waste and six related to effluent discharge. Four of the six effluent non-compliances related to a heavy rain-on-snow event in January. A discussion of the non-compliances, impacts and responses are highlighted in Chapter 11 of this report.

The 2011 Annual Environmental Report is available online at www.riotintoalcaninbc.com. Locate the report by selecting Media then Environmental Reports from the drop-down menu. The website also provides information on key environmental performance indicators.

Questions or comments are welcome and may be made through the contact page on the website.

Main entrance with HSE awareness, Kitimat Operations

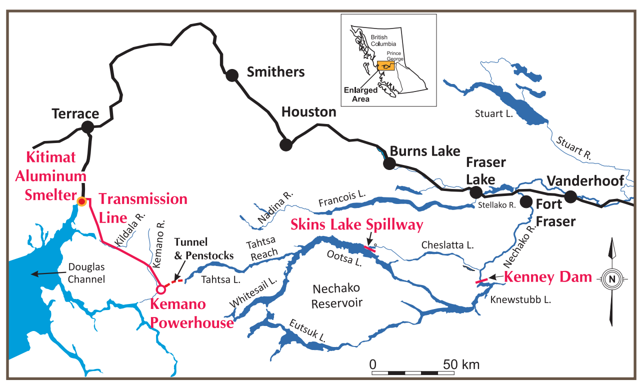
Operational overview

Chapter 2

Rio Tinto Alcan operates a multi-faceted industrial complex in northern British Columbia, which is one of the largest in the province. Its focal point is the Kitimat aluminum smelter located on the northwest coast, at the head of Douglas Channel.

On December 1, 2011 Rio Tinto authorized the addtional investment of US$2.7 billion for the modernization of the Kitimat Operations by 2014 (www.kitimatworksmodernization.com). During 2011, start-up preparations for the Kitimat Modernization Project (KMP) influenced effluent, waste management and emissions. Key changes are presented in Chapter 4, Effluents and Chapter 8, Waste management. In August 2010, Lines 7 & 8 were decommissioned. 2011 was the first full year following the closure, where a full year of data was collected to investigate any potential changes on the air emissions.

Kitimat Operations had an annual rated production capacity of 282,000 tonnes of aluminum. The main raw material used at the smelter is alumina ore, large volumes of which are imported from international suppliers and delivered by ship. Alumina is composed of bonded atoms of aluminum and oxygen. An electrolytic reduction process is



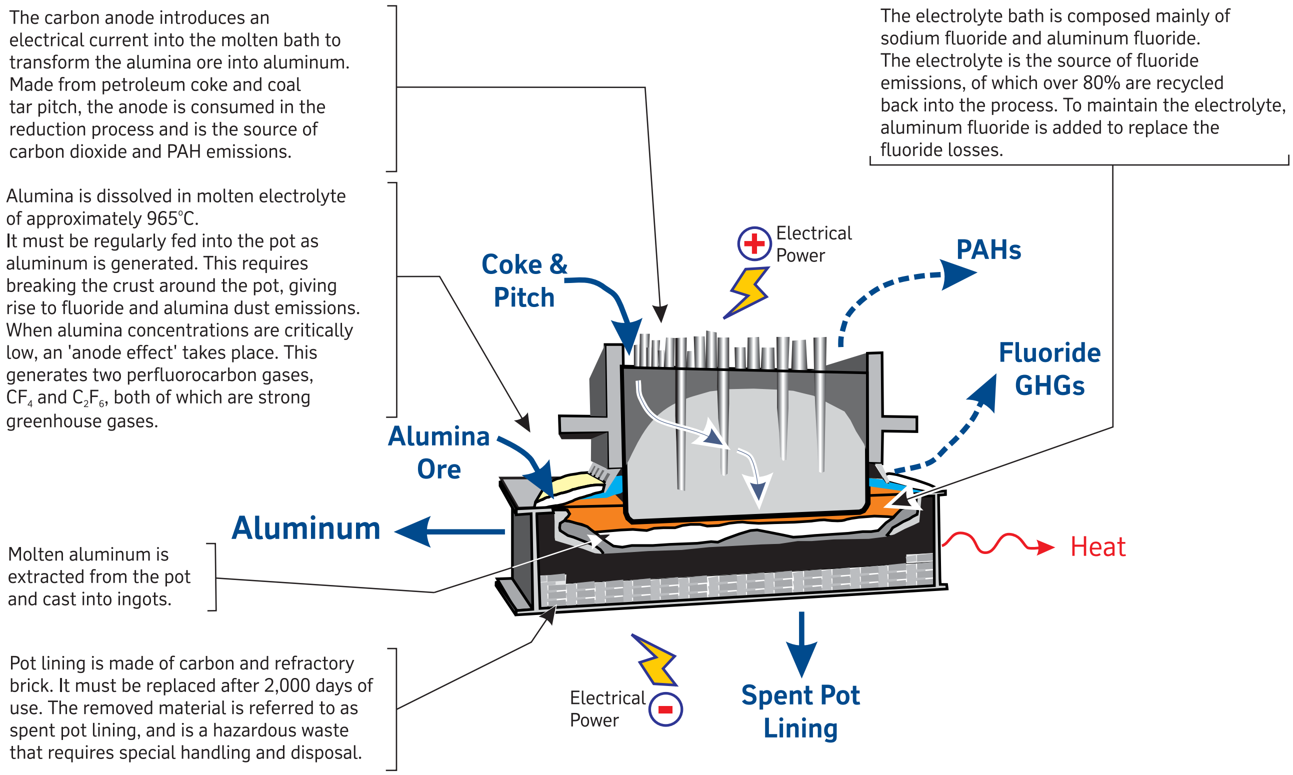
B.C. Operations industrial facilities

used to break the bond and produce aluminum (refer to Aluminum manufacturing process illustration, page 2.2).

Electrolytic reduction takes place in the potroom buildings. These buildings house specially designed steel structures called pots. The pots function as electrolytic cells. They contain a molten bath or electrolyte made up mainly of highly conductive cryolite in which alumina ore is dissolved. Electricity flows through the electrolyte from an anode to a cathode. The electricity breaks the aluminum-oxygen bond. The heavier aluminum

Aluminum manufacturing process

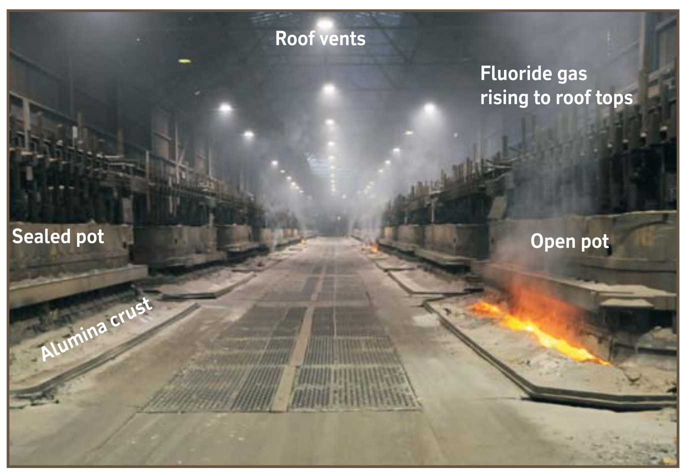
Aluminum metal is extracted from raw alumina using an electro-chemical 'reduction process' that takes place within a steel-encased pot.



molecules sink to the bottom of the pot in the form of molten aluminum. Molten aluminum is then extracted and transported to one of two casting centres located within the smelter, where it is temporarily stored in holding furnaces. Various alloying materials (such as magnesium, copper, silicon and iron) are added to produce specific characteristics such as strength or corrosion resistance.

The aluminum is then poured into moulds and chilled with water, forming solid ingots of specified shapes and sizes. Kitimat Operations produces three types of ingots: value added sheet, extrusion ingot (in rectangular and cylindrical forms), and trilok ingots, which are sold to customers for remelting resulting in a variety of end-use applications. As part of the modernization project, the cylindrical extrusion line was closed during 2011. Products are shipped to markets in North America and Asia, including the United States, Korea and Japan.

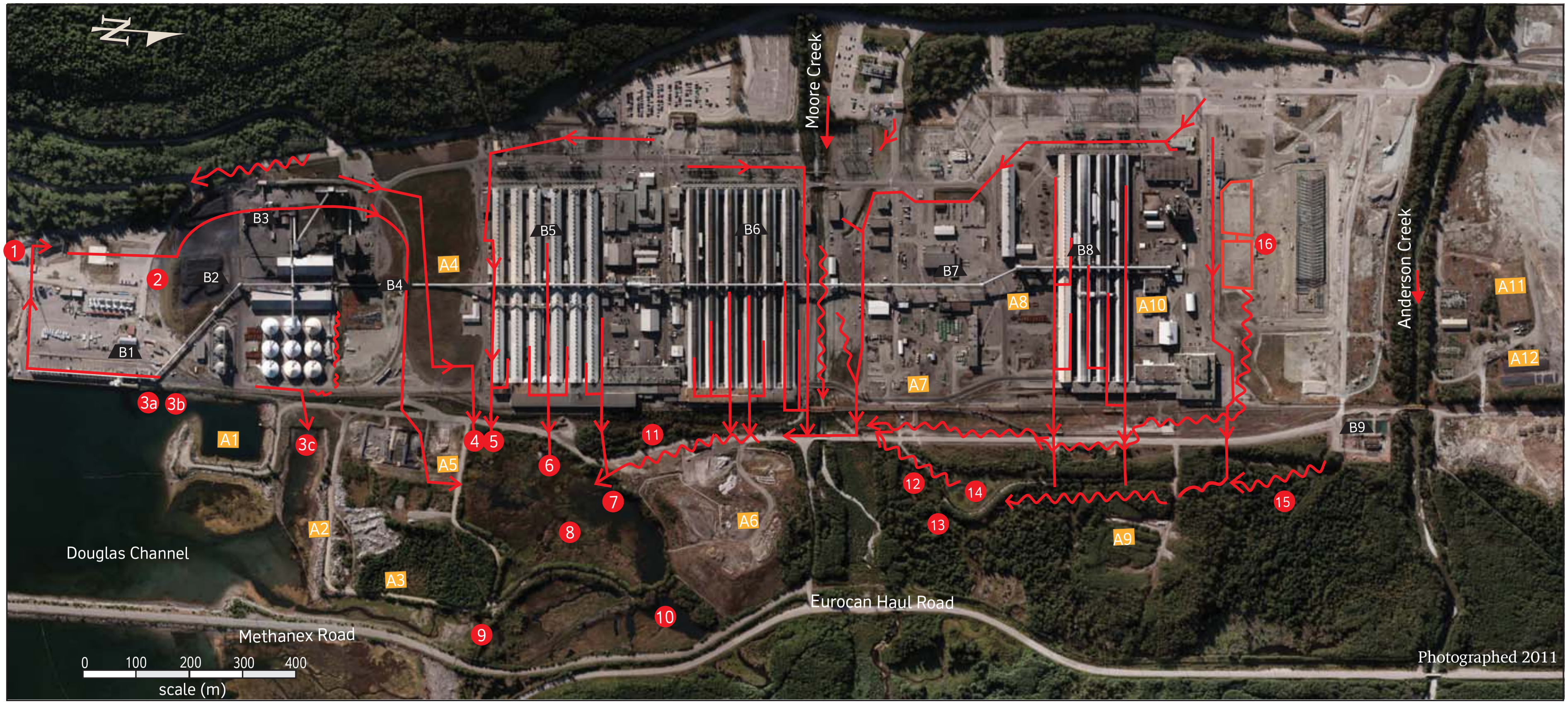
The smelter site also includes facilities that produce raw materials required for aluminum production. An on-site anode paste plant and a calcined coke plant produce materials used in the manufacturing of anodes.



Lines of pots are situated in potroom buildings. The first pot on the right is undergoing an anode effect, while the other pots are functioning normally.

The electrolyte reduction process requires the use of large amounts of electricity. Electricity for Kitimat Operations is generated at the Kemano Operations' powerhouse, a 1,000 megawatt hydroelectric generating station located 75 kilometers southeast of Kitimat. This generating station uses water impounded in the 91,000 hectare Nechako Reservoir in north-central British Columbia.❖

Kitimat Operations map: Effluent system and waste management



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4. J-Stream Discharge
5. Potline 1 Discharge
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Collecting ground core samples for evaluation

Cassette monitoring, Kitimat Operations

Environmental management and certification

Chapter 3

Introduction

The foundation for environmental management throughout Rio Tinto Alcan's global operations is the Health, Safety and Environment (HSE) Policy. HSE directives establish corporate-wide standards on major environmental, health and safety topics.

The HSE Policy and the more specific requirements of the HSE Standards are put into practice at Kitimat Operations through a comprehensive, operation-specific Risk Management System comprised of detailed environmental, health and safety programs and procedures. The system is overseen by a dedicated coordinator who champions risk management and its auditing process. The system is updated through a continual cycle of target setting, implementation, assessment and improvement.

Independent certification

In 2001, Kitimat Operations' Risk Management System was successfully certified under the demanding requirements of ISO 14001, an environmental program of the International Organization for Standardization. ISO 14001 provides independent verification that Kitimat Operations assesses its environmental implications, has procedures in place to address issues, and works continually to lighten its environmental footprint.

In keeping with a corporate-wide commitment to a sustainable management approach, Kitimat Operations achieved an integrated certification in 2003, which combined the ISO 14001 standards (environment), the ISO 9001 standards (production process quality) and the OHSAS 18001 standards (Occupational Health and Safety Advisory Services). While separate certifications to these standards are common, Kitimat Operations is one of the relatively few operations to have developed a single integrated management system that encompasses all of these certification standards.

In 2010, the Rio Tinto Health, Safety, Environment and Quality (HSEQ) Management System was introduced to Rio Tinto Alcan B.C. Operations. In 2011 full implementation of the Rio Tinto HSEQ Management System was completed. This system builds on the requirements of the various ISO standards to improve and sustain the process structure and add a level of rigor.

Audit program

Independent ISO compliance and conformance audits are conducted as a condition of certification. Two surveillance audits took place in 2011, each conducted over a five-day period. The results were positive and Kitimat Operations' integrated certification to all three standards was successfully maintained. Ten additional internal audits were completed, covering all organizations within B.C. Operations concerning the HSEQ Management System, ISO 14001, ISO 9001 and OHSAS 18001 requirements. Future audits will be conducted according to the Rio Tinto audit protocols which require an audit every year for the Management System and every two years for the HSEQ Performance Standards.

Excellence in managing HSE responsibilities is essential to our long-term success and is the hallmark of Rio Tinto Alcan's activities.

Health, Safety and Environment Policy

Rio Tinto Alcan is committed to protecting the environment, preventing pollution and safeguarding the health, safety and welfare of those who work at or visit our sites in a manner that is respectful of local laws, customs and cultures.

Our vision is supported by our core values of fairness and honesty, integrity, respect, teamwork, trust and transparency, passion for excellence and tenacity in achieving results. As a business, we care about people and the world in which we live.

Health, Safety and Environment (HSE) guiding principles

- We collaborate to identify and eliminate, or otherwise control, HSE risks to our people, our communities and the environment in which we operate.
- We use the HSE risk framework and the application of the hierarchy of controls to develop and deliver measurable HSE objectives and targets.
- We deliver our HSE responsibilities and ensure our employees are equipped and trained to achieve our Goal of Zero incidents, injuries and illnesses.
- We encourage our employees to adopt a healthy, safe and environmentally conscious lifestyle both at work and home.
- We improve and support our suppliers' and customers' contribution to sustainable development by promoting the responsible use and multiple benefits of our products.
- We continuously seek to reduce the environmental footprint of our operations and related activities by:
  - Improving the energy efficiency and our natural resource consumption,
  - Reducing, reusing and recycling materials to minimise waste and pollution,
  - Endeavouring to protect and restore natural biodiversity,
  - Identifying and undertaking specific programmes to reduce the greenhouse gas emissions of our business.
- We generate sustainable HSE performance through long term, mutually beneficial relationships with our communities, governments, our business partners and other stakeholders.

To support the implementation of this policy, Rio Tinto Alcan commits to:

- Holding leaders accountable for the delivery of HSE improvements and for providing the necessary resources to do so.
- Requiring all in the business to understand their responsibilities and accountabilities in respect of HSE and to visibly demonstrate their commitment, through their actions, towards achieving our Goal of Zero incidents.
- Complying with all applicable laws, Rio Tinto HSE standards and other voluntary requirements.
- Developing, implementing and maintaining recognised management systems and programmes that ensure appropriate and consistent implementation of this HSE Policy, globally.
- Obtaining assurance of our HSE policy and management systems through regular audits and reviews of our performance.
- Promoting effective employee, contractor and stakeholder participation in and awareness of HSE issues and programmes related to our operations through training, communication and regular public reporting of performance.

As individuals, we personally commit to applying the principles of this policy to continuously improve *The way we work* every single day.

Jacynthe Côté, chief executive, Rio Tinto Alcan

February 2009

RioTintoAlcan

Rio Tinto Alcan Primary Metal Health, Safety, Environment and Quality Policy

BC Operations has implemented and maintains the current version of the international standards within an *Integrated Risk Management System:*

- ISO 14001 & OHSAS 18001 and,
- ISO 9001 for Casting Operations.

The aim of the BC Operations management system is to retain and continually improve its recognized world-class standards through:

- Health Safety Environment (HSE) programs;
- Management's demonstrated leadership and commitment;
- Line ownership and active participation;
- Cooperation and communication with employees and stakeholders.

Rio Tinto's Business Improvement techniques and sustainability principles are utilized to define and review measurable objectives and targets.

To achieve, maintain and continually improve performance, BCOP'S will:

- Achieve implementation of Rio Tinto's Health Safety Environment Quality (HSEQ) Management system.
- Utilize proactive and transparent communication to identify hazards, assess risks and develop safe working procedures to prevent incidents, and promote a healthy and safe environment for all who work for the operations.
- Comply with legislation, including international accords, as a minimum standard and where appropriate, apply more stringent internal targets through Rio Tinto's HSE standards and joint OHS&E programs.
- Maintain and test plant site emergency preparedness procedures.
- Achieve efficient use of energy, fuels and raw materials, by integrating best practices into procedures and processes.
- Minimize waste and greenhouse gas generation through process control improvements and by utilizing recycling initiatives wherever possible.
- Minimize or render harmless releases to the environment that may result from the operations and/or products.
- Provide value-added quality and on-time products to customers by effective consultation, networking technologies and by utilizing problem solving techniques as applicable.
- Formally train and support employees, contractors and suppliers to comply with Rio Tinto's HSEQ philosophy and policies.
- Regularly monitor the effectiveness of the management system by utilizing internal and external auditing programs, and by communicating objectives to employees, customers, suppliers, regulatory authorities and community stakeholders.
- Monitor the performance of its operations by conducting regular management reviews.

This policy complies with Rio Tinto's HSE policy and commitment

July 2009

Paul Henning, vice president, Rio Tinto Alcan Primary Metal North America

B-Lagoon outfall

Salt water addition, B-Lagoon

Effluents

Chapter 4

Introduction

Sources and infrastructure

Surface runoff from the smelter site, originating as snowmelt and rain, accounts for most of the water discharge. Seasonal precipitation varies significantly, and total discharges can be over 100,000 m^3 per day during fall and winter storms.

All effluents, with the exception of several storm drains, are directed to B-Lagoon through one of six inflows, referenced as: F-Lagoon, D to B-Lagoon Diversion, North B Discharge, Middle B Discharge, Potline 1 Discharge, and J-Stream Discharge (refer to **Effluent system and waste management map** on page 2.3). With the implementation of the Kitimat Modernization Project Water Management Plan during the summer of 2011, the Project related surface water runoff was captured, treated and tested before its discharge into A-Lagoon contributing to the prevention of F-Lagoon overflows during the year end heavy rain period.

Whether water is in use at the smelter or accumulating through surface runoff, it collects contaminants from various sources. It is directed through underground drains and surface channels to one of the six inflows, then into B-Lagoon that discharges into the Douglas Channel.

B-Lagoon consists of a primary and a secondary pond: Upper and Lower B-Lagoons. Designed to remove contaminants by sedimentation or settling and to smooth fluctuations of inflows and contaminant levels, B-Lagoon discharges effluent continuously into the Douglas Channel. In 2011, the average discharge rate was 40,431 m^3 per day.

The retention time for water in the lagoon is usually more than ten hours (confirmed by measurements conducted in 2005), but is reduced to about five hours during runoff events and heavy rainfall. Lagoon vegetation acts as an additional filter to reduce the impact of certain contaminants and is particularly effective during the summer months.
In addition to the B-Lagoon outfall, an emergency outfall accommodates significant inflow surges. F-Lagoon and D-Lagoon are also designed with emergency overflows in case of significant surge.

In 2011, there were two overflow events. One occurred at F-Lagoon in January. This event resulted in three permit non-compliances that are described in Chapter 11, Summary of Non-Compliances. There was also an overflow event at B-Lagoon in January.

Heavy rain on snow resulted in a significant volume of water in the lagoons. This event resulted in one permit non-compliance which is also described in Chapter 11.

Discharge measurements related to permit requirements and additional monitoring are described below in the following 2011 Performance section.

Water quality monitoring

Effluent into and out of B-Lagoon is monitored, as is the water quality. On-going monitoring of groundwater quality is conducted in specific areas of the Kitimat Operations site, including a landfill formerly used to dispose of spent potlining. Results from the water quality monitoring program are reported in the 2011 Performance section below and groundwater monitoring information is reported in Chapter 9, Groundwater Monitoring.

2011 Performance

Long-term trends

Dissolved fluoride and dissolved aluminum are two of the most meaningful performance indicators of the plant effluent quality. Average annual performance for both have been consistently maintained below permit levels in recent years. **Figure 4.1** illustrates the long-term trend for these performance indicators. In 2011, all of the performance indicators increased in comparison to 2010 levels. These increases can be attributed to the greater amount of rainfall experienced in 2011.

For 2010, Rio Tinto Alcan set a target to reduce dissolved aluminum loading that is directly tied to the Ecological Target Initiative. The focus in 2010 was on developing a plan to achieve the target by 2013. The focus in 2011 was in cleaning and maintaining the courtyards in the potrooms to reduce the dissolved aluminum loading. This initiative is a corporate strategy to improve water quality for its operations globally.

Flow variability

Variability in the flow from B-Lagoon into Douglas Channel is mainly a function of precipitation. As shown in **Figure 4.2**, peak rain events and flows occurred in January, February and from August through December. The total amount of rainfall in 2011 was 30 per cent higher than 2010 (3,344 mm of rain fell in 2011 compared to 2,448 mm in 2010). The heaviest rain event ocurred in January, November and December.

Figure 4.1 — Long-term performance, dissolved fluoride, aluminum & total suspended solids, B-Lagoon

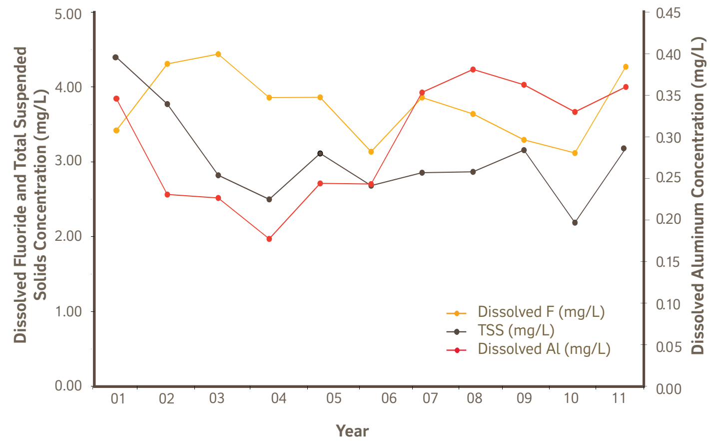
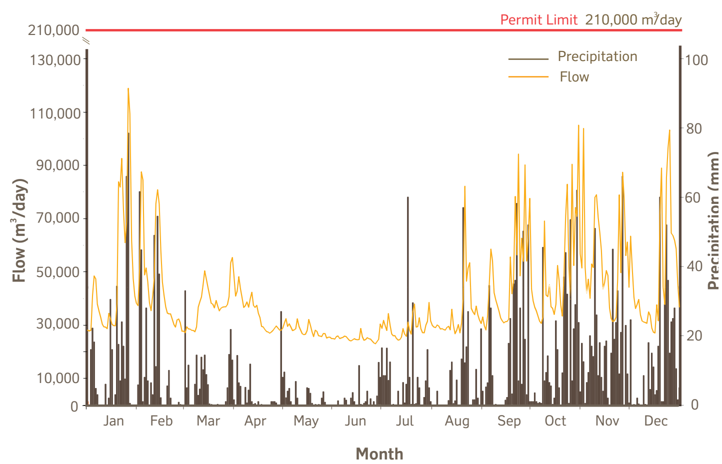


Figure 4.2 — Flow variability, B-Lagoon, 2011



Groundwater monitoring

Figure 4.3 — Dissolved fluoride, B-Lagoon, 2011

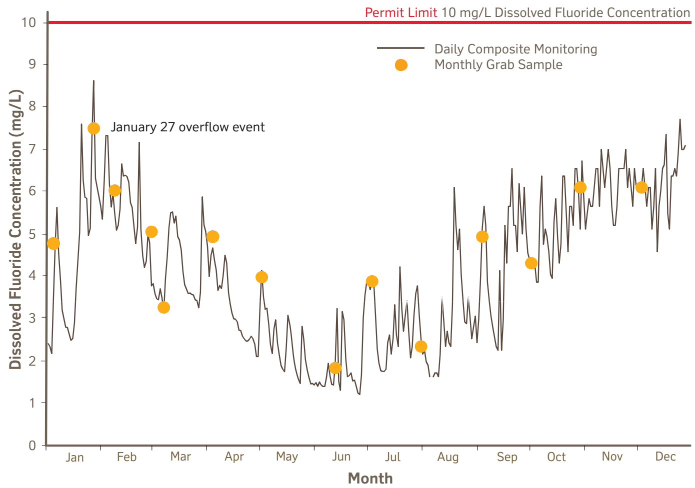
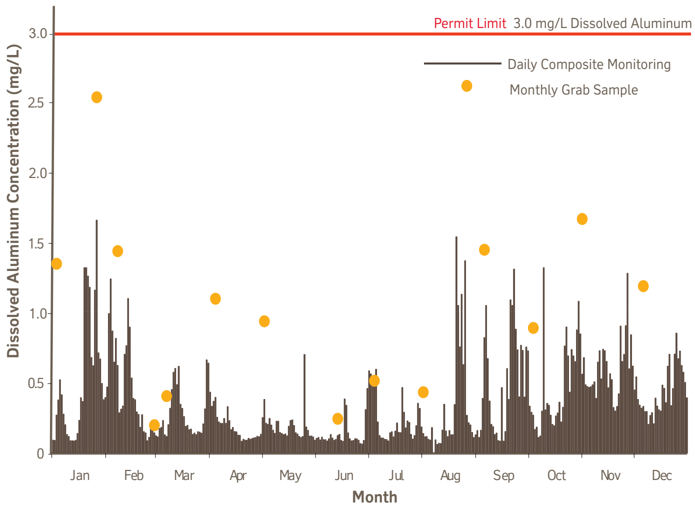


Figure 4.4 — Dissolved aluminum, B-Lagoon, 2011



B-Lagoon

Dissolved fluoride

Dissolved fluoride originates mainly from the leaching of a landfill formerly used to dispose of spent potlining. Other sources of fluoride are raw material losses and air emissions captured in runoff. The amount of precipitation and surface runoff can significantly influence the levels of dissolved fluoride.

Dissolved fluoride is monitored using continuous monitoring, daily composite sampling and monthly grab sampling. Daily composite and grab samples are sent to an outside laboratory for analysis (refer to Chapter 12, Glossary for sample method definitions).

The permit specifies a concentration maximum of 10 mg/L of dissolved fluoride in effluent, and this level was not exceeded in 2011. Average dissolved fluoride concentration for the year from composite sampling was 4.27 mg/L. This value is higher than 2010. The long-term trend is illustrated in **Figure 4.1**. The 2011 composite and grab sampling results **(Figure 4.3)** profile the higher concentrations that occurred during the higher precipitation and surface run off during the year.

Dissolved aluminum

Aluminum metal at Kitimat Operations, such as finished products stored outside at the wharf, have a very low solubility and contribute little to the discharge of dissolved aluminum.

Alumina – the main raw material used at Kitimat Operations – also has low solubility; however, it is used in very large quantities (approximately 323,190 tonnes of alumina delivered in 2011) and can be a significant contributor of dissolved aluminum in effluent.

In addition to its use as a raw material, alumina is also used in the scrubbing process to remove fluoride from smelter emissions. Some scrubbed alumina is released through the potroom basements and roofs. In this form, scrubbed alumina has a higher solubility and is a contributor to both dissolved aluminum and dissolved fluoride.

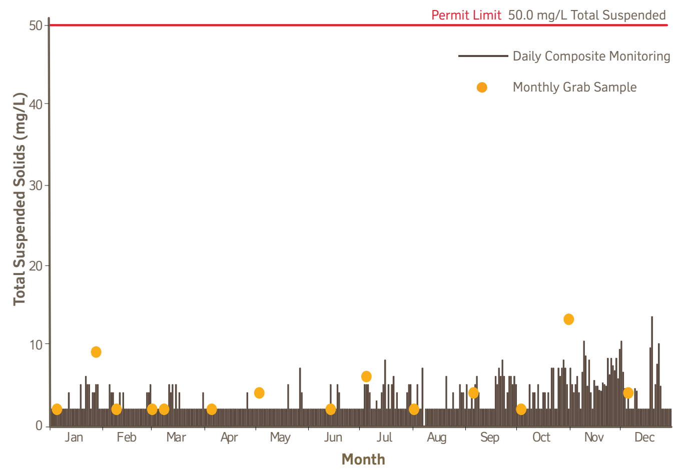
In 2011, concentrations of dissolved aluminum did not exceed the maximum permit limit of 3.0 mg/L. The annual average of dissolved aluminum concentration was 0.36 mg/L (**Figure 4.4**).

Total suspended solids (TSS)

Solids that remain suspended in discharge from B-Lagoon include small amounts of materials used in industrial processes at the smelter and other naturally occurring substances like dust, pollen and silt. There is a proportional relationship between TSS levels and concentrations of both dissolved aluminum and polycyclic aromatic hydrocarbons (PAH), because these contaminants are usually bound to suspended solids in water when entering the B-Lagoon system.

B-Lagoon is a large and well-vegetated area that is highly efficient in absorbing and processing effluent compounds. The permit specifies a concentration maximum of 50 mg per litre of TSS in effluent. Concentrations in 2011 were much lower than the permit level. The annual average concentration for the composite samples was 3.2 mg/L. The highest concentrations occurred during October, November and December **(Figure 4.5)**.

Figure 4.5 — Total suspended solids, B-Lagoon, 2011

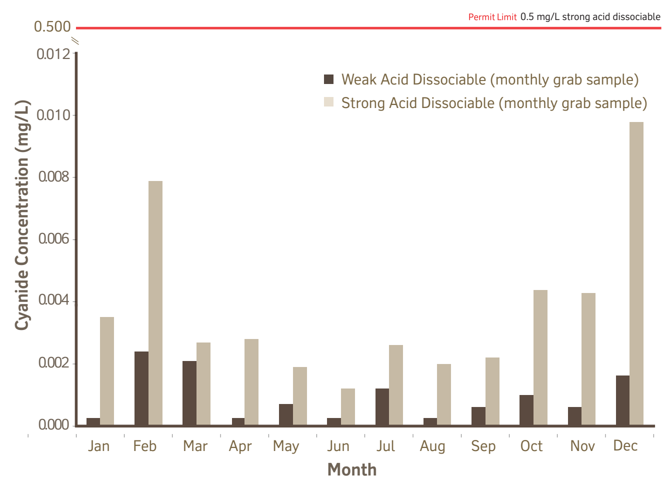


Cyanide

Cyanide is formed during the electrolytic reduction process and retained in the cathode lining material known as spent potlining (SPL). In the past, material in the cathode was deposited in the on-site SPL landfill. Today, 100 per cent of newly generated SPL is shipped off-site to a secure landfill. Groundwater and the bottom of the SPL landfill lining interact, generating a leachate containing cyanide. The J-Stream in-flow captures this groundwater leachate, depositing it into B-Lagoon.

The permit specifies a maximum concentration of 0.5 mg per litre of strong acid dissociable cyanide (the more abundant, although less toxic form) in B-Lagoon. Concentrations are determined from the monthly grab samples. The permit level was not exceeded in 2011. Weak acid dissociable cyanide is also monitored, although there is no permit requirement. The level of this form of cyanide was also low with an average concentration of 0.00089 mg/L **(Figure 4.6)**.

Figure 4.6 — Cyanide, B-Lagoon, 2011



Temperature

Water used for cooling is the major source of effluent at Kitimat Operations. B-Lagoon is designed to retain effluent long enough to ensure water temperatures are not elevated when discharged.

The permit requires that the temperature of the lagoon discharge does not exceed 30°C. Temperatures were within permit requirements during 2011 **(Figure 4.7)**.

Figure 4.7 — Temperature, B-Lagoon, 2011

Conductivity, hardness, salt water addition and toxicity

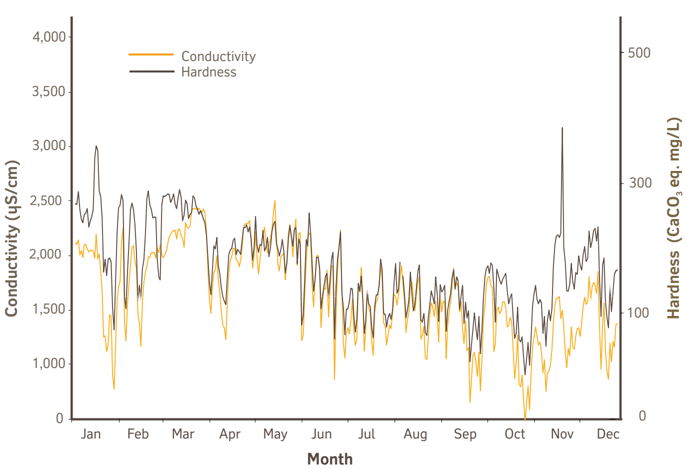
Studies conducted in B-Lagoon demonstrate that the addition of salt water to the effluent reduces toxicity by increasing conductivity and hardness levels. Since 1997, salt water has been pumped into B-Lagoon at the connection between the primary and secondary ponds. As per permit requirements, the addition of salt water is monitored and managed to maintain non-toxic discharges.

In 2008, an independent consulting firm conducted a review to examine the correlation between seawater addition rates, conductivity, hardness, and toxicity. The review was in fulfillment of section 8.2.5 of the multi-media permit requirement. Results confirmed that the addition of sea water was successful at reducing the toxicity of the B-Lagoon effluent. The data also confirmed the best way to predict toxicity is via aluminum concentration, conductivity and pH.

Conductivity and hardness are monitored on a continuous and daily composite basis respectively, even though there are no permit limits for either parameter **(Figure 4.8)**. These measures provide information that ensures the salt water addition system is contributing to the elimination of toxicity at the B-Lagoon outfall**.**

Water toxicity is determined through the application of a bioassay test. The toxicity of water discharged from B-Lagoon is tested by exposing juvenile rainbow trout to the effluent in a certified laboratory under controlled conditions ($96LC_{50}$ bioassay test). The permit requires monthly monitoring with a survival rate of at least 50 per cent for trout tested. All effluent discharge bioassay tests at B-Lagoon passed during 2011.

Figure 4.8 — Conductivity & hardness, B-Lagoon, 2011



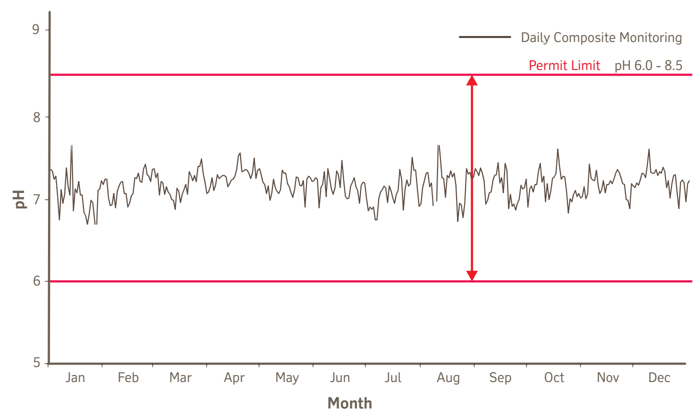
Acidity

A variety of contaminants can influence the acidity of effluent, by either increasing or decreasing the pH. A pH level of 7.0 is neutral, and water sources found adjacent to Kitimat Operations (Anderson Creek and the Kitimat River) usually have a pH level slightly below neutral (i.e. acidic, rather than basic).

Acidity is monitored using a variety of methods (continuous, daily composite and monthly grab samples). Daily composite samples are provided to an external laboratory for analysis.

The permit requires that the pH of the effluent is maintained between 6.0 and 8.5. The 2011 annual pH composite sample average was 7.2. All sample measurements were within the permit limits during 2011 **(Figure 4.9)**.

Figure 4.9 — Acidity, B-Lagoon, 2011



Polycyclic Aromatic Hydrocarbons (PAH)

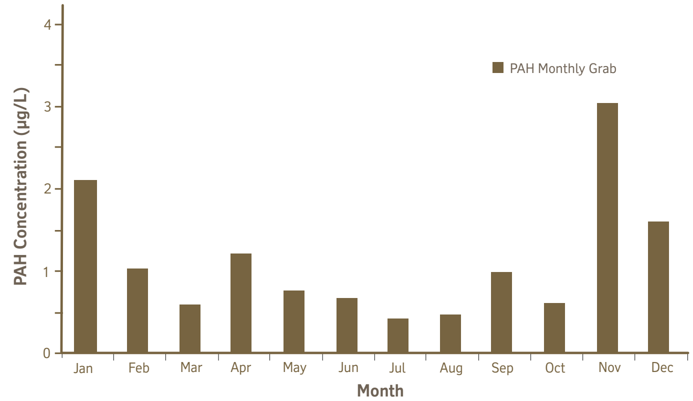
Polycyclic Aromatic Hydrocarbons (PAH) are a large family of chemical compounds (more than 4,000 have been identified), generated by the incomplete combustion of organic material.

Various operations at the smelter generate PAH (in both particulate and gaseous forms). They originate in discharges primarily from potroom roof dust captured in precipitation and surface runoff. Other sources include raw material (green coke and pitch) handling.

PAH are monitored using two methods: weekly analysis of composite and monthly grab samples. PAH are also analyzed from grab samples taken during special events.

B-Lagoon discharges are monitored and analyzed for 18 of the most common PAH compounds, although there are no permit levels for PAH in effluent **(Figure 4.10)**. The highest PAH concentration was obtained from the grab sample collected in November. Higher PAH concentrations were also obtained in the November, December and January monthly grab samples. Higher concentrations are common in the winter months due to the generation of higher effluent flows. ❖

Figure 4.10 — Polycyclic Aromatic Hydrocarbons, B-Lagoon, 2011



Scow grid and stormwater discharge area

Emissions, Kitimat Operations

Emissions

Chapter 5

Introduction

This chapter describes the results of on-going monitoring of various gaseous and particulate matter in air emissions from Kitimat Operations. Performance results relate to type and source of emissions.

Types

The two types of emissions generated on-site are gaseous and particulate based. Gaseous fluoride (Fg), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAH) and nitrogen oxides (NO_x) are the primary emissions monitored.

Sources

Major sources of air emissions at Kitimat Operations include the potroom roofs and exhaust stacks. Wind-blown or nuisance dust (picked up from raw material storage piles, process ventilation systems and during raw material transportation) is another contributor to air emissions.

Pollution control equipment, situated at various locations in and around the smelter, includes the coke calciner pyroscrubber, potroom dry scrubbers and dust collectors. Air emissions are collected and processed via these pieces of equipment to remove most airborne pollutants.

Air quality monitoring

In addition to monitoring emissions, regular and extensive air quality and vegetation monitoring is conducted in the Kitimat valley. Information on these monitoring programs is detailed in Chapters 6 and 7.

Stack sampling from casting area

2011 Performance

Gaseous fluoride (Fg)

Three major sources contribute to fluoride emissions: the molten bath reduction process; coke and pitch density and quality; and alumina ore density, size and quality. Fluoride emissions are monitored at roof top locations on potroom lines 2A, 3B, 4B and 5B (refer to the yellow dots on the potroom roof sampling locations graphic, page 5.8).

The molten bath dissolves the alumina ore by an electrolytic reduction process through which aluminum is produced. The bath is composed primarily of sodium fluoride and aluminum fluoride and is the main source of fluoride emissions at Kitimat Operations. More than 80 per cent of fluoride emissions are collected and recycled back into the process, but some escapes do occur.

The carbon anode – made from coke and pitch – is consumed in the molten bath reduction process. Problems with anode integrity (such as cracking) are major contributors to fluoride gas escapes. When anode integrity is compromised, carbon enters the electrolyte. This results in overheating of the pots, thus breaking the gas seal and reducing gas collection efficiency.

Changing global markets for coke indicate that the quality of the coke continues to be unpredictable. Lower quality coke contributes to anode quality problems. Consultation with anode integrity experts are on-going to provide an improved understanding on how to operate with market ready materials.

The alumina ore quality has a significant impact on the reduction process primarily through the grain size of the alumina used, and the amount of impurities it contains. Anode effects are chemical reactions that occur when the amount of dissolved alumina in a pot is too low. The reaction contributes to both fluoride and greenhouse gas emissions.

Over the past three decades, there has been a substantial reduction in gaseous fluoride emissions. Between 1974 and 1981 significant decreases resulted from improvements in collection systems, dry scrubbing, pot design and operating procedures. Smart-Feed Logic was introduced as a way of improving the process of feeding alumina ore into the pots. The Smart-Feed system alerts potroom staff to the occurrence of anode effects so that corrections can be made.

Effective December 2007, a new permit limit which includes potroom and dry scrubber emissions was set by the Ministry at 50 tonne of gaseous fluoride loading per month and replaces the rate measurement of gaseous fluoride per tonne of aluminum. The gaseous fluoride emissions rate is still tracked internally and

Figure 5.1 — Long-term performance, gaseous fluoride rate measurement, potroom roofs

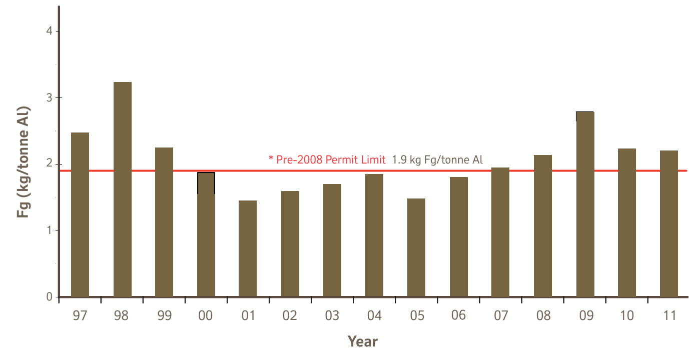
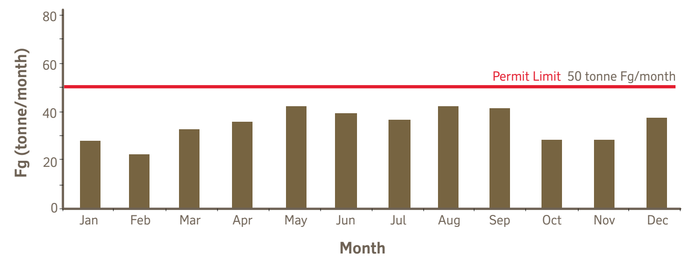


Figure 5.2 — Gaseous fluoride emissions loading measurements, potroom roofs, 2011



showed a slight decrease in 2011 compared to 2010 **(Figure 5.1)**. The annual average fluoride emissions loading during 2011 was 34.5 tonne gaseous fluoride per month compared to 39.3 tonne gaseous fluoride per month in 2010. During 2011, there were no loading monthly exceedances of the gaseous fluoride emissions limit **(Figure 5.2)**.

There is a relationship between the number of exception pots and fluoride emissions: the higher the exceptions, the higher the emissions. Exception pots are pots that are not operating normally. In 2011, their numbers were greatest in April; however, the average number of exception pots were lower in 2011 than in 2010.

The number of low magnitude pots in Lines 3-5 increased in March and stayed higher than normal for April and part of May. There was a smaller and shorter period of increase at the end of August. This is an indicator of anode problems which may produce sick pots.

Sick pots are pots that cannot be sealed properly due to elevated temperatures in the bath. This is the result of sludge and/or anode problems. Repairs require the pots to remain open. While the sick pots are open, they release emissions. It can take time to get these pots back to normal operating conditions.

Leftover metal will also result in process upsets. There was an increase in leftover metal in June, July, August, September and at the end of December. Process upsets in 2011 were a combination of weak anodes and leftover metal.

Actions taken to address the process upsets include:

- maintenance work on the crane rails to improve the ability to remove metal from the pots
- prioritize removal of metal in Lines 3-5, and
- complete process correction on all the sick pots.

Gaseous fluoride is known to have negative impacts on the health of vegetation. Due to elevated gaseous fluoride emissions during the growing season, the routine annual vegetation survey found elevated levels of fluoride in vegetation adjacent to the plant site (refer to Chapter 7).

Sulphur dioxide (SO_2)

Sources of sulphur dioxide at Kitimat Operations include green coke and coal tar pitch. Both are raw materials used to manufacture anodes. Coke calcination is a process used to change green coke into a useable form. Sulphur dioxide emissions occur during calcination and the electrolytic reduction process through which aluminum is produced.

From 1993 to 1999, the sulphur dioxide emission permitted was 20.7 tonne per day on an annual average basis. This level was achieved until 1998 through the increased use of low-sulphur coke. However, low-sulphur coke has created problems with anode integrity, which contributed to exceedances of the limits for both sulphur dioxide and fluoride emissions. Raw material adjustments were required to bring fluoride emissions down, but made the old sulphur dioxide permit limit unfeasible.

In December 1999, a new sulphur emissions permit limit was set at 27.0 tonne per day. Long-standing and on-going ambient air monitoring and vegetation sampling programs specific to sulphur dioxide confirm an absence of environmental impacts associated with this higher permit limit. SO_2 emissions have decreased from 15.1 tonne per day in 2010 to 14.2 tonne per day in 2011. The emission levels remained well below the permit limit **(Figure 5.3)**. Monthly average performance was also consistently below the permit limit **(Figure 5.4)**.

Figure 5.3 — Long-term performance, SO_2 emissions, Kitimat Operations

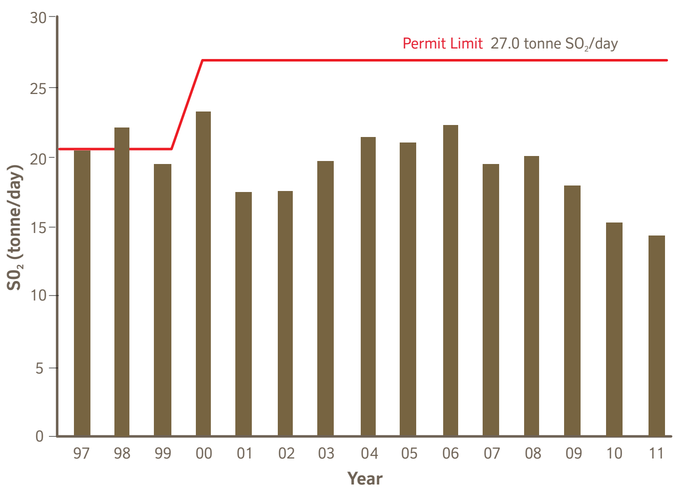
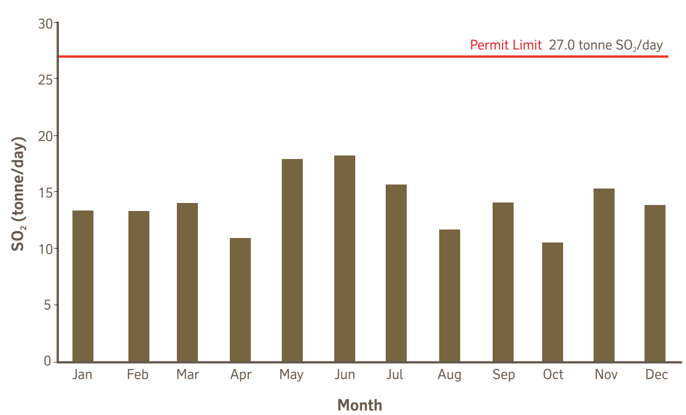


Figure 5.4 — SO_2 emissions, Kitimat Operations, 2011



Polycyclic Aromatic Hydrocarbons (PAH)

PAH are a large family of chemical compounds (more than 4,000 have been identified), which are produced by both industrial processes and various forms of combustion such as wood-burning stoves and forest fires. They occur in emissions from Kitimat Operations primarily as a by-product of anode paste manufacturing, anode baking and anode consumption.

The multi-media environmental permit requires the monitoring of air emissions from representative potroom buildings for 18 of the most common PAH. PAH content in the emissions from Kitimat Operations was lower in 2011 at 108.5 tonne per year compared to 119.6 tonne per year in 2010 **(Figure 5.5).**

In April 2008, an agreement regarding PAH was signed between Rio Tinto Alcan and Environment Canada. The purpose of this agreement was to set environmental performance objectives with respect to atmospheric emissions of PAH from Rio Tinto Alcan's Söderberg plants in B.C. (Kitimat) and Quebec (Shawinigan and Beauharnois). As of 2008, the environmental performance objective determined for Kitimat Operations was 0.8 kg per tonne Al. The average PAH emissions for 2011 were the same as 2010 at 0.63 kg per tonne Al **(Figure 5.6).**

Nitrogen oxides (NO_x)

Nitrogen oxides are produced through the operation of the smelter and the coke calciner. Nitrogen oxides are relevant to smog and other potential air quality concerns (which have not been a significant problem in the Kitimat valley).

NO_x emissions are estimated using a combination of actual measurements and U.S. Environmental Protection Agency emission factors. Smelter-wide NO_x emissions for 2011 are estimated at 617 tonne per year **(Figure 5.7)**.

The coke calciner operated 282.8 days in 2011 down from 304.1 days in 2010. The NO_x emission rate from the calciner increased to 19.2 kg per hour in 2011 from 18.1 kg per hour in 2010.

Potroom dry scrubbers

The potrooms are a major source of emissions at Kitimat Operations, and the potroom dry scrubbers are therefore very important components of the plant's pollution control system.

Continuous monitoring for gaseous fluoride is conducted on each potroom dry scrubber to ensure elevated emissions levels are promptly addressed.

The permit requires multi-faceted dry scrubber compliance tests on a regular basis on three of the six operating scrubbers. In 2011, no non-compliances occurred **(Table 5.1)**.

When a dry scrubber stops functioning for any reason (downtime), gases are re-routed from the non-operating scrubber to two adjacent scrubbers. Occasionally, electrical or mechanical problems can result in dry scrubber downtime without interconnection to an adjacent unit. Such incidents are tracked as a percentage of total possible operating hours **(Table 5.2)**.

Potroom particulate emissions

Potroom roofs are the largest contributor of total particulate emissions. Particulate emission samples are taken at each of the representative potroom buildings using six sample positions on each building during two consecutive sample periods, once every quarter.

Long-term performance of potroom particulate emissions have been consistently below the permit limit except for 2009 **(Figure 5.8)**. The permit limit of 7.5 kg particulate per tonne Al is applied to average emissions calculated quarterly.

Figure 5.5 — Long-term performance, PAH emissions, loading measurement, potroom roofs

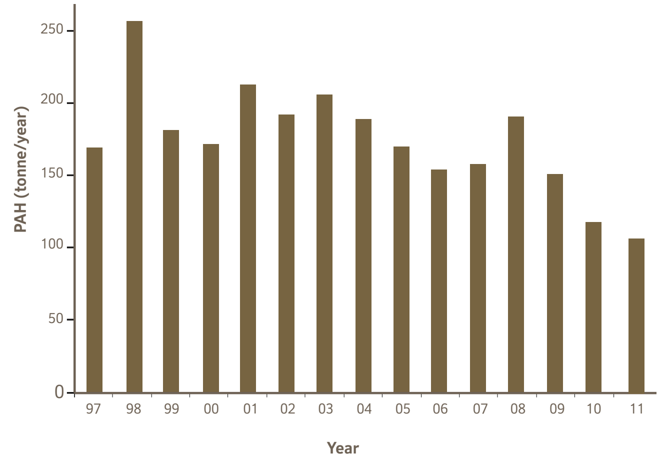


Figure 5.6 — Long-term performance, PAH emissions, rate measurement, potroom roofs

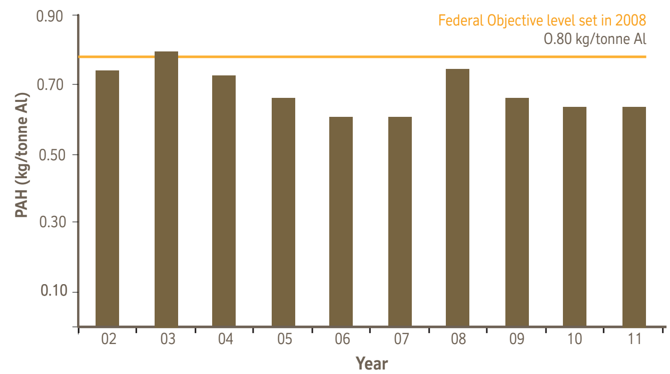
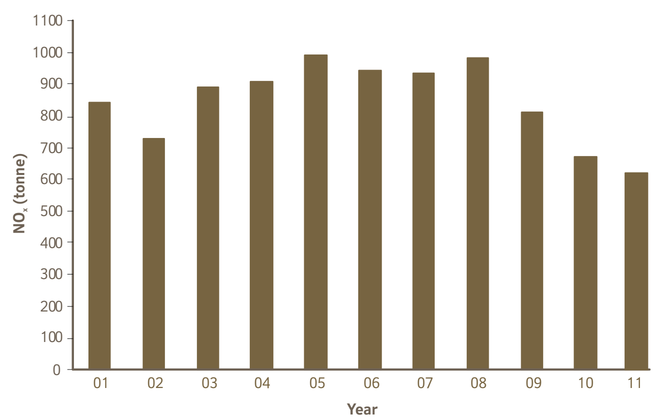


Figure 5.7 — Long-term performance, nitrogen oxide emissions, Kitimat Operations



Potroom

Table 5.1 — Potroom dry scrubbers annual stack tests, 2011

Performance Measure	Dry Scrubber #		
	1	2	4
Date	9 Jul	6 Jul	8 Jul
Flow (m³/min) Permit Limit: 1,560 m³/min	1127.0	1368.8	845.4
Total Particulates (mg/m³) Permit Limit: 70 mg/m³	6.1	5.8	16.0
Particulate Fluoride (mg/m³) Permit Limit: None	0.1	0.1	0.3
Gaseous Fluoride (mg/m³) Permit Limit: None	1.2	1.1	0.5
Sulphur Dioxide (mg/m³) Permit Limit: None	268.4	244.8	779.9
Date	12 Aug	10 Aug	17 Aug
Polycyclic Aromatic Hydrocarbons (mg/m³) Permit Limit: None	0.21	0.23	0.12

Table 5.2 — Potroom dry scrubbers downtime, 2011

Percentage Downtime			
January	No Occurence	**July**	0.09%
February	No Occurence	**August**	No Occurence
March	No Occurence	**September**	No Occurence
April	No Occurence	**October**	No Occurence
May	No Occurence	**November**	0.07%
June	No Occurence	**December**	No Occurence

In 2011, potroom particulate emissions were below permit levels in three out of four quarters with an annual average of 6.6 kg particulate per tonne Al. The result in the third quarter was 8.4 kg particulate per tonne Al **(Figure 5.9)**. Particulate emissions from the potroom roofs accounted for 96.8 per cent of total particulate emissions for Kitimat Operations in 2011 **(Figure 5.10)**.

Calcined Coke Plant

Two different emission sources at the calcined coke plant (the pyroscrubber and the cooler) are monitored relative to permit limits for particulate content. In 2011, no non-compliances occurred. Emissions from the coke calciner's pyroscrubber are also monitored for sulphur dioxide and nitrogen oxide concentrations **(Table 5.3)**.

Recovery Plant

The discharge of air contaminants from the Potlining Mix Plant are controlled using a dust collector (DC231).

Figure 5.8 — Long-term performance, particulate emissions, potroom roofs

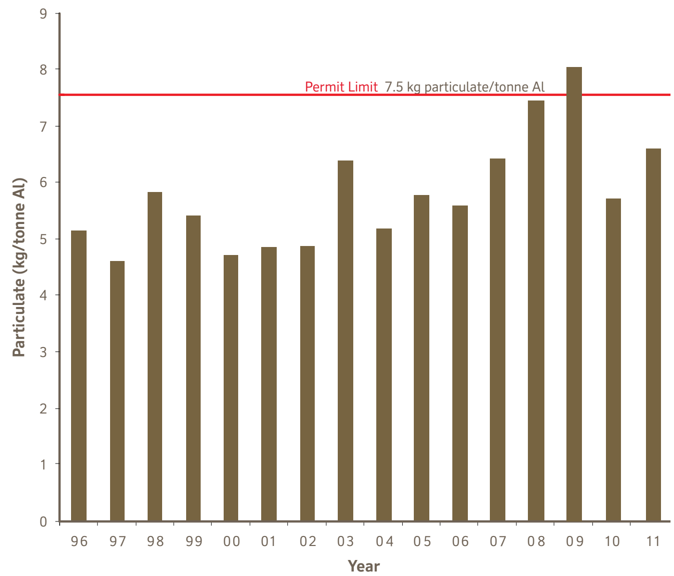


Figure 5.9 — Particulate emissions, potroom roofs, 2011

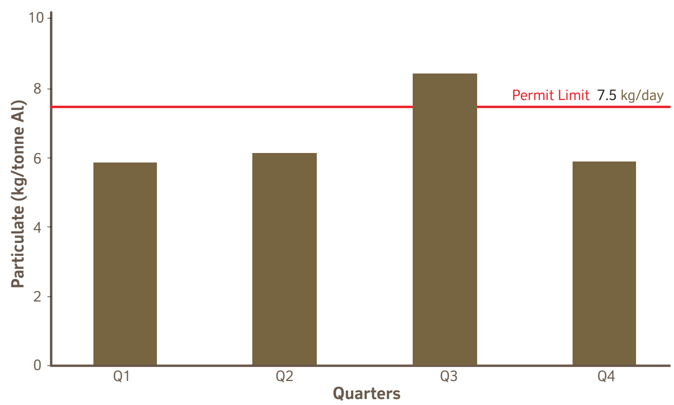
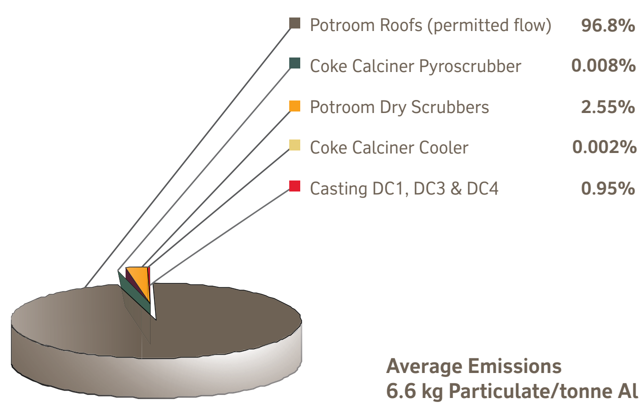


Figure 5.10 — Particulate emissions, Kitimat Operations, 2011



The total particulate permit limit for DC231 is 50 mg/m³. Total particulate emissions from this source were 10.2 mg/m³ in 2011.

Anode Paste Plant

Various emission sources at the anode paste plant are controlled using dust collectors. The dust collector discharge stacks are monitored relative to permit levels for total particulate content **(Table 5.4)**. All these sources were in compliance with the permit in 2011.

Chlorine consumption

Chlorine is used during the process of casting aluminum ingots. Gaseous chlorine is mixed with nitrogen and argon and used to flux (remove) impurities from the molten metal. The permit limit for chlorine consumption is 300 kg per day. This limit has not been exceeded since 1999 **(Figure 5.11, Figure 5.12)**.

Natural gas consumption

Natural gas is widely used at Kitimat Operations in various applications where heat is required. Variables affecting usage levels include production levels and the availability of energy generated by the hydroelectric facility at Kemano Operations.

Table 5.3 — Calcined Coke Plant, annual stack test, 2011

Emissions Performance Measure	Calcined Coke Plant Pyroscrubber	Calcined Coke Plant Cooler
Particulates (kg/hour) Permit Limit	14.9 (Jun) 11.0 (Sep) 21.1	2.7 (Jun) 3.3 (Sep) 3.9
SO_2 (kg/hour) Permit Limit	216.1 (Jun) 232.5 (Sep) n/a	1.1 (Jun) 0.6 (Sep) n/a
NO_x (kg/hour) Permit Limit	16.8 (Jun) 21.5 (Sep) n/a	n/a n/a n/a

Table 5.4 — Anode Paste Plant, annual stack test, 2011

Source	Particulate Permit Limit (mg/m³)	Particulate Emissions (mg/m³)
Dust Collector DC10	120	12.3
Dust Collector DC11	120	18.1
Dust Collector DC12	120	24.7
Dust Collector DC13	120	72.4
Dust Collector DC14	120	14.0
Dust Collector FC3	120	15.7
Dust Collector DC111	50	48.3

Figure 5.11 — Long-term performance, chlorine consumption, casting

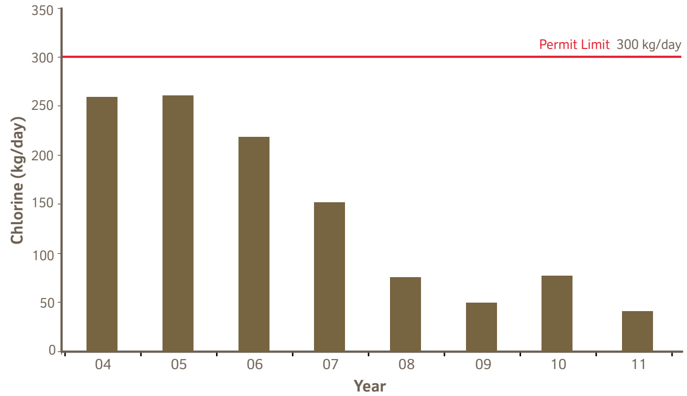
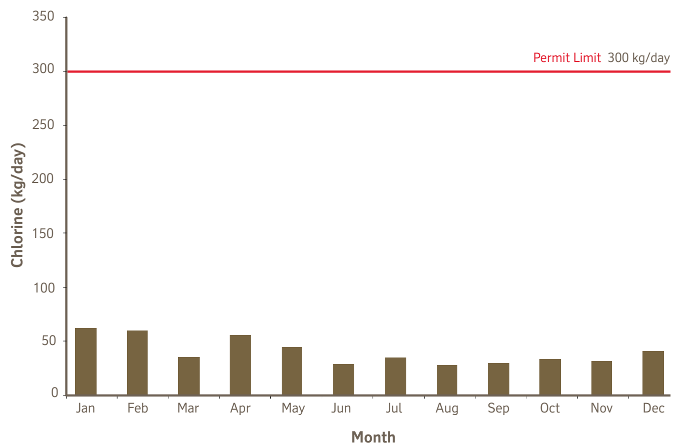


Figure 5.12 — Chlorine consumption, casting, 2011



Kitimat Operations consumption rates and associated emissions are calculated using standards developed by the U.S. Environmental Protection Agency. During the past year, natural gas consumption decreased in the casting area by 16.0 per cent and was reduced in the anode paste plant by 6.9 per cent. There was also a decrease in the smelting area by 8.2 per cent. Plant-wide in 2011, consumption decreased by 11.5 per cent **(Table 5.5)**.

Greenhouse gas emissions

There are a number of sources of greenhouse gas (GHG) emissions at Kitimat Operations **(Figure 5.13)**. Most emissions occur during the smelting process, and most smelting-related emissions are attributable to anode effects **(Figure 5.14)**. Anode effects produce perfluorocarbons (PFC), a form of GHG with a particularly high carbon dioxide equivalency.

Kitimat Operations GHG emissions decreased in 2011 to 4.85 from 5.01 tonne of CO_2 equivalent, per tonne of aluminum production. This was due primarily to a decrease in anode effect "minutes" (average duration multiplied by frequency) **(Figure 5.15)**.

Figure 5.13 — Total GHG emissions by source, 2011

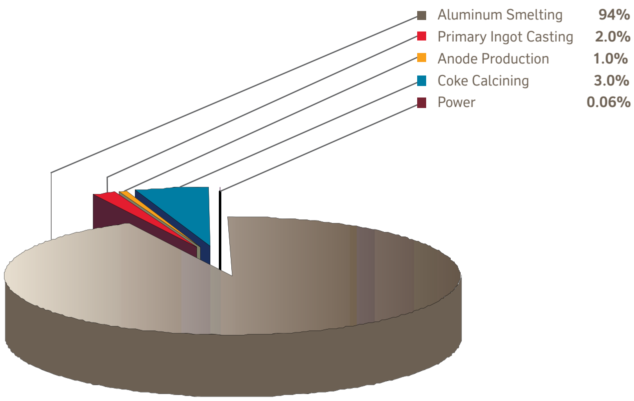


Figure 5.14 — Breakdown of aluminum smelting GHG emissions by consumption, 2011

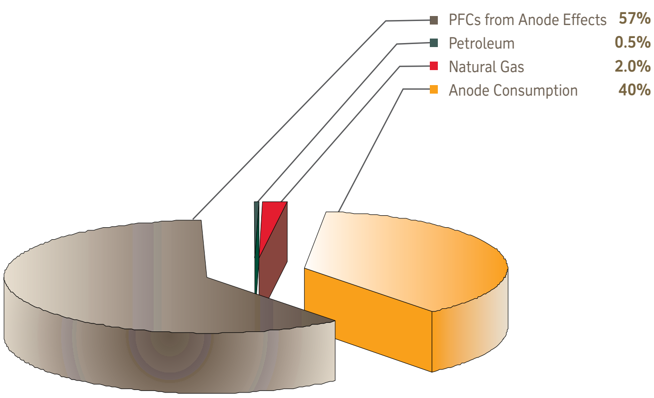
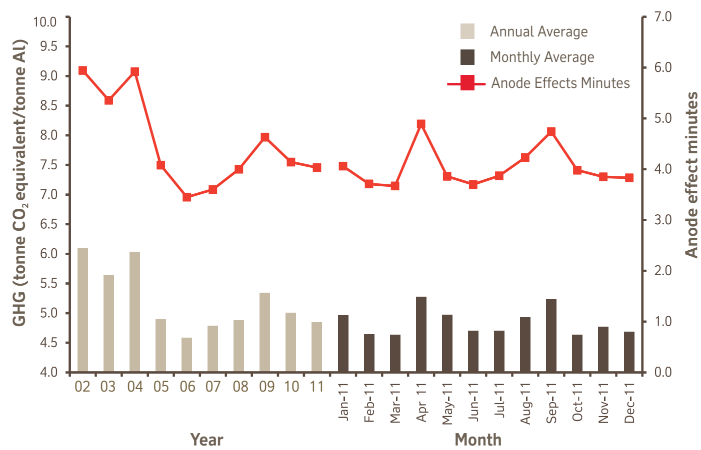
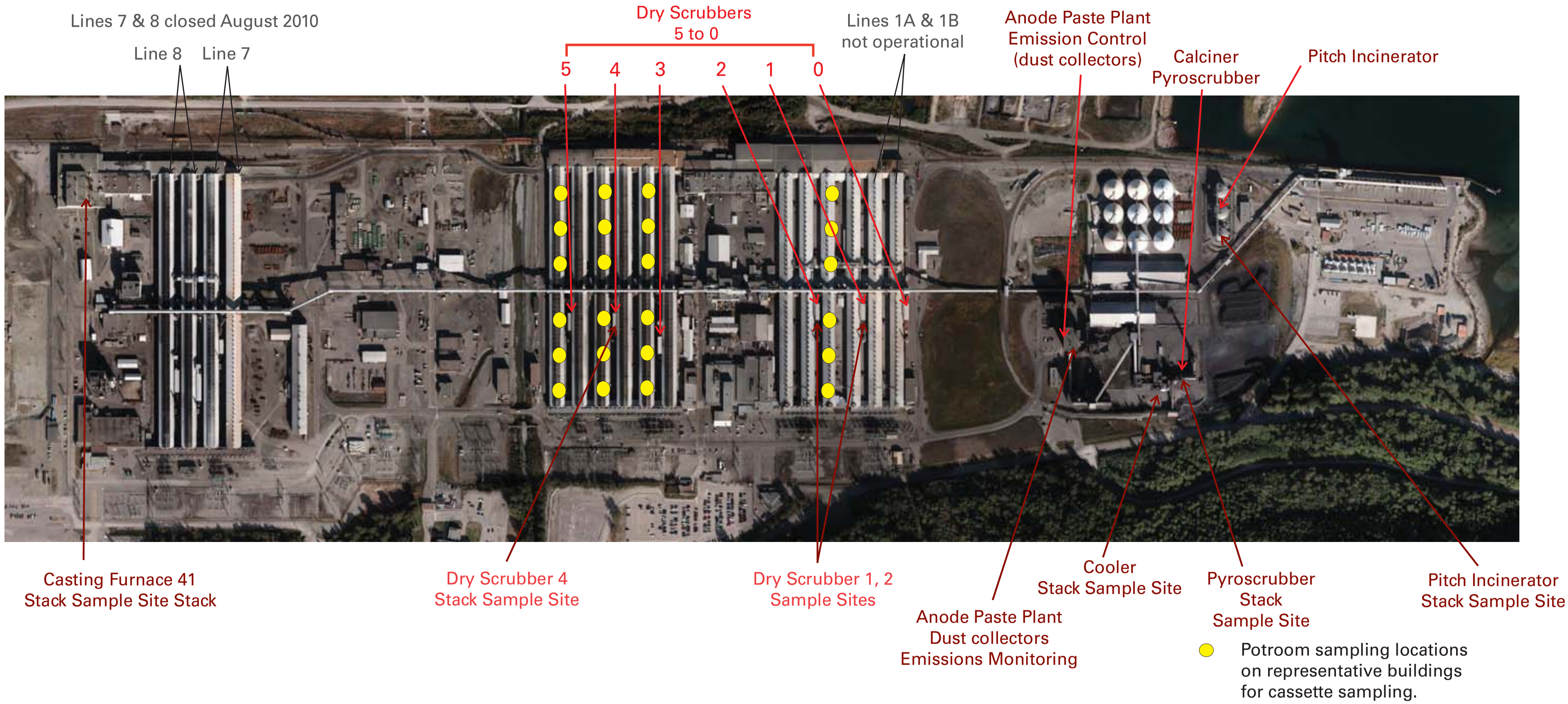


Table 5.5 — Natural gas consumption & associated emissions

Year	Natural Gas Consumption m^3/yr	Associated Emissions for Natural Gas Use (tonne/year)			
		Nitrogen Oxides	Total Particulates	Sulphur Dioxide	Carbon Monoxide
2000	23,328,987	37.33	2.84	0.22	31.35
2001	24,719,317	39.55	3.01	0.24	33.22
2002	26,718,911	42.75	3.25	0.26	35.91
2003	26,412,184	42.26	3.21	0.25	35.50
2004	27,610,071	44.18	3.36	0.27	37.11
2005	24,423,744	39.08	2.97	0.23	32.83
2006	25,403,363	40.65	3.09	0.24	34.14
2007	25,837,200	41.34	3.14	0.25	34.73
2008	25,931,400	41.49	3.15	0.25	34.85
2009	24,013,100	38.42	2.92	0.23	32.27
2010	23,564,629	35.89	2.73	0.22	30.14
2011	20,864,400	33.38	2.54	0.20	28.04

Figure 5.15 — Long-term & 2011 monthly performance, GHG emissions





Potroom roof sampling locations

This illustration shows the locations on each of the potoom roofs where samples are collected, with respect to gaseous and particulate fluoride, total particulates and polycyclic aromatic hydrocarbons. There are six roof sampling locations on respective potroom buildings that house the cassette sampling technology.

Cassette sampling is a technology approved by the U.S. Environmental Protection Agency and is used at representative locations on representative buildings. Results from cassette sampling locations are used for permit compliance reporting. ❖

Camp Site air monitoring station

Air quality monitoring

Chapter 6

2011 Ambient air network improvements

Significant changes were made to the hydrogen fluoride (HF) ambient monitoring network in 2010 that continued in 2011. These changes occurred with the collaboration and approval of the Ministry. B.C. Operations evaluated and updated the HF ambient monitoring network by replacing the current HF analyzers with a newer, more efficient technology. An independent consulting firm as well as the Arvida Research and Development Center (ARDC) engaged to evaluate the monitoring methods, equipment and to advise on network improvements. Changes were made based on recommendations.

Refinements to the ambient monitoring network were implemented:

- Installation of meteorological station at the old Yacht Club.
- Relocation of the Whitesail station sulphur dioxide monitoring equipment to the Riverlodge station.
- Installation of a relative humidity probe at the Whitesail station.
- Implementation of the 2011-2013 passive monitoring program to increase knowledge on dispersion of HF and SO_2 emissions.

Network overview

B.C. Operations conducts continuous ambient air quality monitoring at five stations in the lower Kitimat valley. The monitoring regime tests for and measures the concentrations of a variety of pollutants in the air. The five monitoring stations – Riverlodge, Whitesail, Haul Road, Camp Site and Kitamaat Village – and their monitoring parameters are illustrated in **Figure 6.1**.

The collected air quality data are used to compare regional air quality results with federal and provincial guidelines. These data are then analyzed to:

- Track variations and trends in regional air quality.
- Assess the impact of specific emission sources.
- Assess and refine air quality management strategies.
- Support research on the impacts of air quality on property, vegetation and health.

Five air quality parameters are monitored: hydrogen fluoride (HF), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAH), and two levels of fine particulate matter. Particulate matter is referred to as PM_{10} and $PM_{2.5}$ and is measured against size thresholds of 10 and 2.5 microns, respectively.

Meteorological (weather) monitoring data are collected at all five monitoring stations plus the Yacht Club station.

Precipitation monitoring and analysis is undertaken using samples collected at the Haul Road station. The weather and the precipitation data provide additional insight into air quality data interpretation.

Quality assurance and control

The validation of air quality data is conducted using a quality control/quality assurance process. The quality control component is to ensure that all instrument maintenance and operational guidelines for the instrument are being followed correctly and documented.

Air quality monitoring stations in the Kitimat valley are operated by an independent consultant. A technician performs weekly inspections and routine maintenance on the equipment. In 2011, an improved Maintenance and Calibration Program was implemented. The purpose of this program is to ensure that monitoring equipment is maintained according to the equipment supplier's specifications and RTA's standards.

The program includes the following:

- master calendar of all scheduled maintenance and calibration activities
- roster of all peripheral equipment at each ambient air station
- equipment and calibration job plans
- site review sheets
- spare parts list

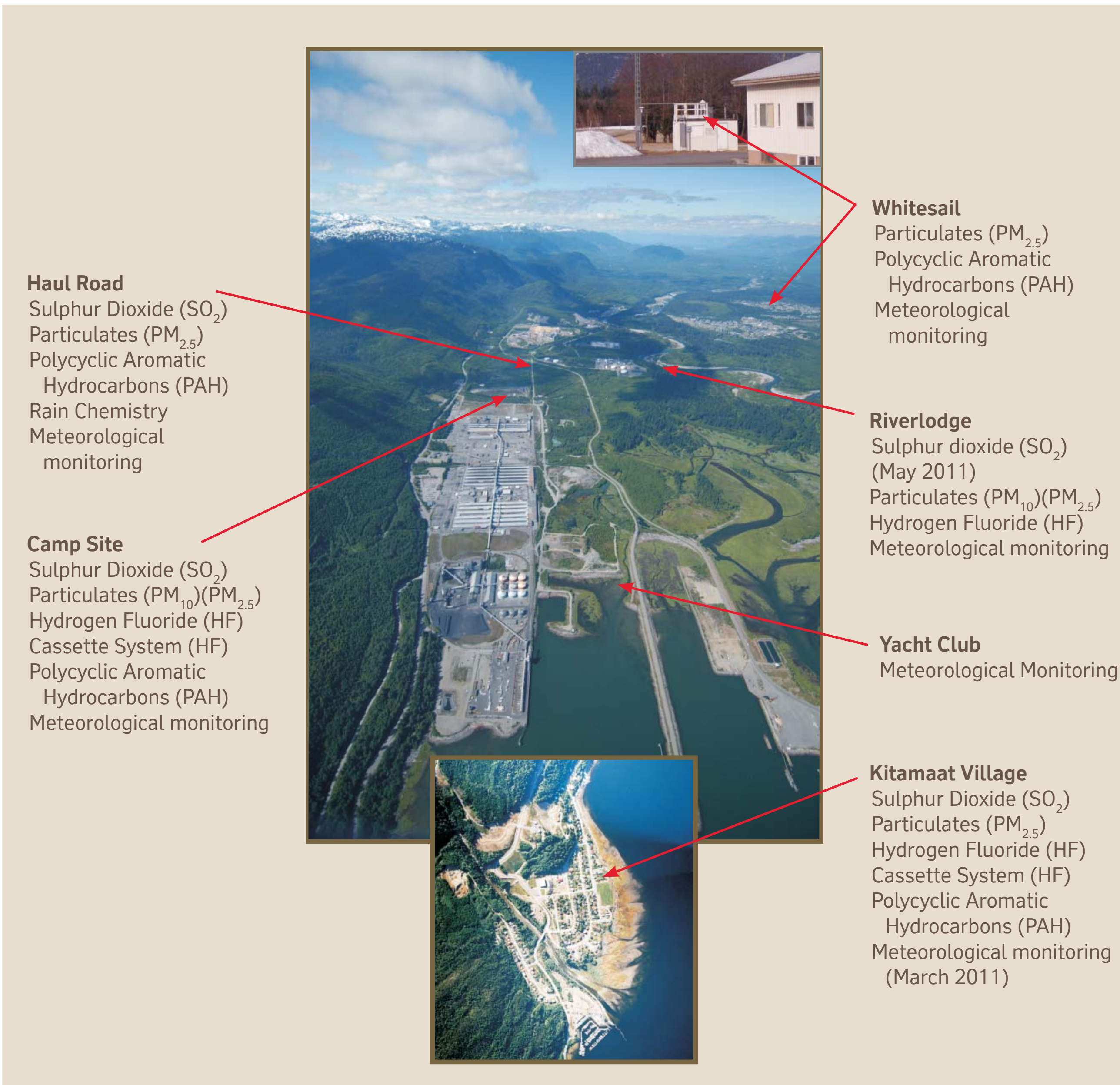


Figure 6.1 — Ambient air monitoring stations and parameters monitored by B.C. Operations, 2011

Part of the calibration activities is to perform validation tests. The purpose of these tests is to quantify the percent deviation between measured and actual concentrations. In order to do this, a known concentration of HF gas is injected into the analyzer and the equipment will give a response. A procedure to perform these tests was developed in collaboration with ARDC and the Ministry. The tests performed by B.C. Operations and the Ministry on the Picarro analyzers in 2011 showed approximately 10 per cent deviation.

Air quality data are reviewed monthly, validated and submitted to the Ministry. In the event where remedial actions are required to ensure the validity of the data, this information is reported to the Ministry.

The quality assurance procedure is conducted by Ministry staff. This involves visits twice per year to the sites. A review of station and instrument documentation, condition and a reference audit calibration check on each instrument being operated under permit is completed.

The results of the quality control/quality assurance process are then used to validate the data collected by the Provincial Air Quality Monitoring network.

Weather monitoring

Two new meteorological stations became operational in 2011, one at the Kitamaat Village station and the other at the Yacht Club located at the south end of the Plant site. Each station measures temperature, wind direction and wind speed. Additionally, the Kitamaat Village and Whitesail stations measure relative humidity.

The meteorological or weather monitoring program operated by B.C. Operations is carried out to approved Ministry standards. In the event that air quality monitoring data indicate a problem on a particular date, weather data can provide insight into pollutant sources and other contributing factors.

2011 Monitoring results

Hydrogen fluoride (HF)

As of December 2011, all Tess Com analyzers (wet chemistry) were decommissioned. There are currently three upgraded Picarro analyzers (cavity ring down spectroscopy) operating in the network. The only station that obtained a full year of data with the same analyzer (Picarro) is the Camp Site station. The other two stations measured HF concentrations partly with the older technology and the newer technology.

The annual average measurement at Riverlodge was 0.1 part per billion (ppb) with the Tess Com from January to September and 0.3 ppb with the Picarro from August to December.

The Camp Site station is considered a fenceline station and is located north of the operating smelter. The purpose of this station is to provide understanding on levels of emissions at the source. An annual average of 0.8 ppb was measured with the Tess Com analyzer from January to May and an annual average of 1.7 ppb was obtained with the Picarro analyzer **(Table 6.1).**

The Tess Com was removed from the Camp Site station and installed in the Ministry of Environment Mobile Air Monitoring Laboratory (MAML). This mobile station was present in Kitimat at the old Hospital Site from May to November. The purpose of the monitoring program was to validate the current location of the community station in regards to HF concentrations.

Sulphur dioxide (SO_2)

Ministry air quality objectives define 10 ppb as the maximum desirable level of sulphur dioxide in the air on an annual average and 62 ppb as the maximum desirable concentration on a 24 hour average. No exceedances of either the provincial or federal maximum desirable levels occurred in 2011 **(Table 6.2).**

Particulate (PM_{10} and $PM_{2.5}$)

Fine particulates have a wide variety of sources, both natural and human-caused. In northern B.C., forest fires (prescribed and wild), beehive burners, emissions from fireplaces and wood burning stoves are among the major contributors to fine particulate emissions.

In addition to these primary particulate emissions, further contribution occurs due to gas emissions undergoing physical and chemical reactions. Emissions from Kitimat Operations, including sulphur dioxide and nitrogen oxides, are among the precursors to these secondary particulates.

Ambient air quality objectives established in 1995 defined the 24 hour limit for PM_{10} as 50 µg/m³. The

Table 6.1 — Hydrogen fluoride monitoring, 2011

Station	Annual average (of 24 hour concentrations) (ppb)
Riverlodge	Tess Com - 0.1 (Jan - Sep) Picarro - 0.3 (Aug - Dec)
Kitamaat Village	0.1 Tess Com was decommissioned on December 2, 2011 to be replaced by a Picarro
Camp Site*	Tess-Com – 0.8 (Jan-May) ** Picarro – 1.7

* Classified as a fenceline station: north of operating smelter
** HF analyzer was removed from the Camp Site station and installed in the Ministry's mobile air monitoring laboratory (MAML)

Canada-wide standards established in 2009 defined the 24 hour limit for $PM_{2.5}$ as 25 µg/m³ and the annual arithmetic mean as 8 µg/m³.

Except for the Camp Site station which is considered a fenceline station, the annual average particulate monitoring results **(Table 6.3)** did not exceed the PM_{10} and $PM_{2.5}$ objectives. No exceedences of the provincial maximum desirable levels occurred in 2011.

Polycyclic Aromatic Hydrocarbons (PAH)

PAH are generated by the incomplete combustion of organic material. Various procedures at Kitimat Operations generate PAH, in both dissolved and gaseous forms. They occur in emissions primarily as a by-product of the anode manufacturing process; other sources include vehicle exhaust and smoke from forest fires and wood-burning stoves.

Ambient air monitoring is conducted to test for the presence of some of the most common PAH, although no permit limits exist. Sampling is done on a schedule that is coordinated with the National Air Pollution Surveillance (NAPS) to enable comparison of findings from different monitoring sites.

In 2011, total PAH showed a high degree of variability **(Figure 6.2)**. This is typical when compared to previous years. The distribution of PAH is largely consistent from one station to another, once the distance from the source is accounted for **(Figure 6.3)**.

Whitesail ambient air monitoring station

Table 6.2 — SO_2 monitoring, 2011

Station	Annual Average (of 24-hour concentrations) (ppb)	Days Above the Maximum Desirable Concentration Level (10ppb)
Whitesail**	0.6	0
Riverlodge	0.7	0
Haul Road	1.5	0
Kitamaat VIllage	0.2	0
Camp Site*	5.5	0

* Classified as a fenceline station: north of operating smelter
**SO_2 monitor was moved from Whitesail to Riverlodge station on May 12, 2011

Table 6.3 — PM_{10} and $PM_{2.5}$ monitoring, 2011

Station	PM_{10}		$PM_{2.5}$	
	Annual Average (of 24 hour concentrations) (µg/m³)	Days Above Reference Level (50µg/m³)	Annual Average (of 24 hour concentrations) (µg/m³)	Days Above Reference Level (25µg/m³)
Whitesail	-	-	1.3	0
Riverlodge	6.2	0	2.1	0
Haul Road	-	-	3.0	0
Kitamaat Village	-	-	1.8	0
Camp Site*	15.5	7	9.7	1

* Classified as a fenceline station: north of operating smelter

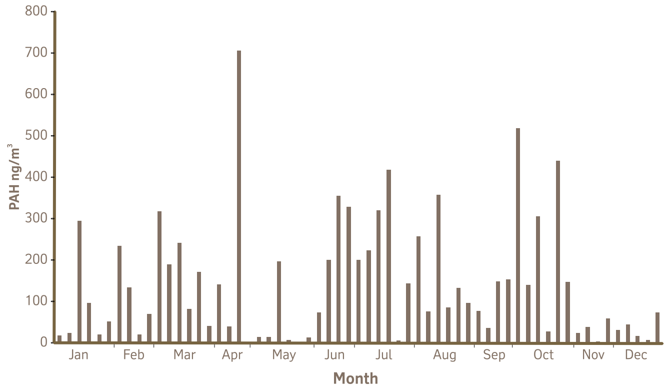
Table 6.4 — Geomean PAH concentrations, 2010 – 2011

Station	2010 Concentrations (ng/m³)	2011 Concentrations (ng/m³)
Haul Road	81	114
Whitesail	17	17
Kitamaat VIllage	15	11

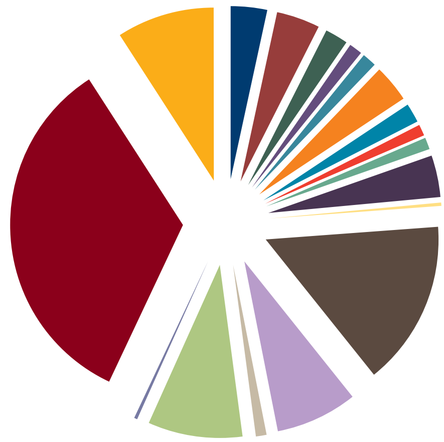
Figure 6.2 — Total PAH, 2011

Figure 6.3 — PAH Distributions, 2011

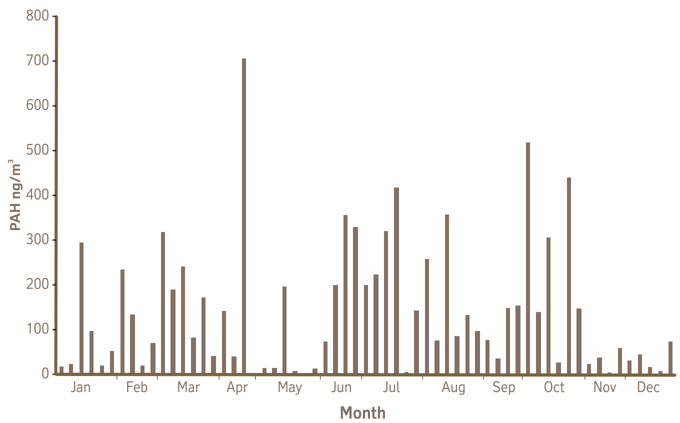
Total PAH: Haul Road Station, 2011



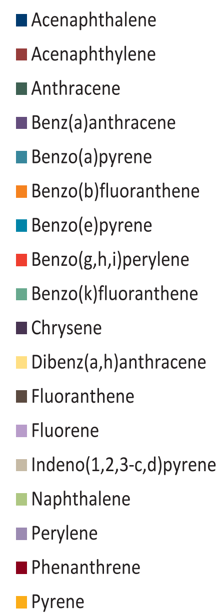
PAH Distribution: Haul Road Station, 2011



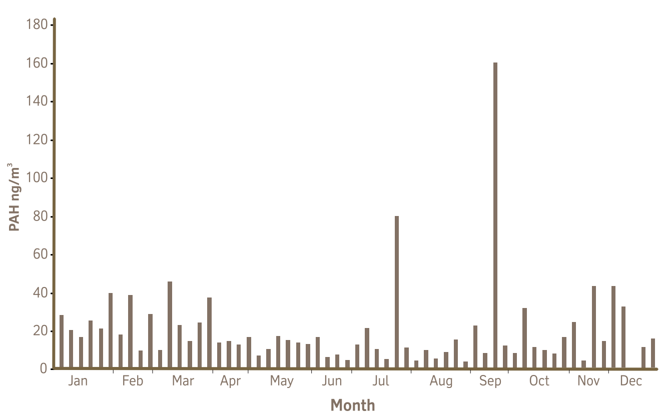
Total PAH: Whitesail Station, 2011



PAH Distribution: Whitesail Station, 2011



Total PAH: Kitamaat Village Station, 2011



PAH Distribution: Kitamaat Village Station, 2011

The geomean PAH concentration for Haul Road was higher in 2011 at 114 ng/m^3 than in 2010 at 81 ng/m^3. At the Whitesail station, the PAH concentration was the same as last year and finally at the Kitamaat Village station PAH concentrations were slightly lower this year at 11 ng/m^3 compared to 15 ng/m^3 in 2010 **(Table 6.4)**.

Rain chemistry

Precipitation samples are collected on a weekly basis from the Haul Road station. Rain chemistry monitoring has been conducted since 2000. Rainfall quantity is recorded. Samples are assessed for criteria for rain acidity and concentrations of 11 specific substances. Annual averages of weekly samples and the geomean measures are presented in **Table 6.5.** There are no permit levels or objectives for this procedure.

High levels of acidity (i.e. a low pH) and concentrations of certain substances are characteristic of the condition referred to as 'acid rain'. Long-term vegetation monitoring (refer to Chapter 7 – Vegetation monitoring) in the Kitimat valley has confirmed an absence of this type of damage.

Table 6.5 — Rain chemistry monitoring at the Haul Road Station, 2011

	Parameter		2005	2006	2007	2008	2009	2010	2011
Precip-itation	Precipitation depth (mm)	average	54.0	47.5	52.1	44.1	30.0	33.2	43.6
		geomean	24.2	17.6	27.2	25.3	11.1	10.6	24.7
Acidity	Rain (pH)	average	4.46	4.5	4.9	4.9	5.4	5.3	5.1
		geomean	4.44	4.5	4.9	4.9	5.3	5.3	5.0
	Acidity (to pH 8.3) $CaCO_3$ (mg/L)	average	6.17	4.47	7.1	7.3	6.0	6.8	5.2
		geomean	5.17	3.98	6.3	6.3	5.0	4.8	3.5
	Acidity - Free (μeq/L)	average	44.22	41.51	30.6	27.9	12.5	12.1	17.6
		geomean	32.09	28.35	13.4	12.2	4.4	4.9	8.5
	Alkalinity - Total $CaCO_3$ (mg/L)	average	5.7	1.1	1.1	1.8	2.2	1.5	0.5
		geomean	1.3	1.1	0.6	1.2	1.7	1.2	0.4
Concentration of specific substances (mg/L)	Chloride (Cl)	average	0.2	0.7	0.3	1.0	1.0	1.1	0.6
		geomean	0.1	0.5	0.3	0.9	0.9	1.0	0.5
	Fluoride (F)	average	1.5	1.3	1.6	2.3	2.4	1.6	1.6
		geomean	1.2	1.1	1.4	2.0	1.7	0.9	1.1
	Sulphate (SO_4)	average	2.1	2.6	2.9	3.8	5.2	3.0	1.4
		geomean	1.8	2.4	2.2	2.9	3.2	1.8	1.0
	Ammonia Nitrogen (N)	average	0.143	0.146	0.087	0.098	0.135	0.122	0.082
		geomean	0.103	0.091	0.072	0.084	0.075	0.074	0.044
	Nitrate Nitrogen (N)	average	0.041	0.034	0.062	0.048	0.066	0.057	0.033
		geomean	0.030	0.027	0.039	0.042	0.049	0.047	0.024
	Total Dissolved Phosphate (P)	average	0.007	0.009	0.020	0.031	0.035	0.006	0.006
		geomean	0.004	0.007	0.012	0.017	0.012	0.005	0.003
	Aluminum (D-Al)	average	0.290	0.255	0.386	0.574	0.621	0.412	0.488
		geomean	0.230	0.220	0.313	0.452	0.372	0.218	0.305
	Calcium (D-Ca)	average	2.660	0.290	0.431	0.668	0.686	0.301	0.147
		geomean	0.210	0.220	0.272	0.463	0.449	0.195	0.099
	Magnesium (D-Mg)	average	1.000	0.060	0.046	0.083	0.079	0.098	0.037
		geomean	0.100	0.100	0.043	0.078	0.074	0.086	0.032
	Potassium (D-K)	average	0.101	0.100	0.200	0.200	0.400	0.320	0.163
		geomean	0.068	0.091	0.105	0.202	0.216	0.185	0.062
	Sodium (D-Na)	average	0.747	1.018	1.121	1.293	2.101	1.172	0.743
		geomean	0.659	0.846	0.847	1.114	1.513	0.752	0.551

Passive monitoring

The passive monitoring program implemented in 2011 was developed in collaboration with the Ministry. The program includes HF monitoring to validate various "hotspots" or areas where high levels of HF were predicted. These levels were determined using the CALPUFF air quality dispersion model. The study was conducted by Trinity Consultants in 2010. SO_2 monitoring was also included to better understand the dispersion patterns.

This three year program consists of 19 sampling locations **(Figure 6.4)** dispersed in the vicinity of the smelter on north-south and east-west transects. A control site was established north-east of Lakelse Lake (Williams Creek). The samples are collected on a weekly basis and the program runs from early spring to early fall.

Passive sampling is an efficient method for monitoring air quality in areas that cannot be monitored on a continuous basis. These systems do not require electrical power; therefore, they are useful tools for measuring ambient pollution where no power is available. The equipment is lightweight and well designed for easy setup and operation.

Passive sampling uses the principle of diffusion and adsorption of the target compounds. Air pollutants diffuse through a membrane and are deposited on an adsorbing surface. No air movement in the apparatus is required. Known constants and equations are then used to estimate average concentrations of target air pollutants. Following exposure, samples are taken to laboratory where the amounts collected are measured. Concentrations are calculated according to exposure time, taking into account the effects of relative humidity and temperature.

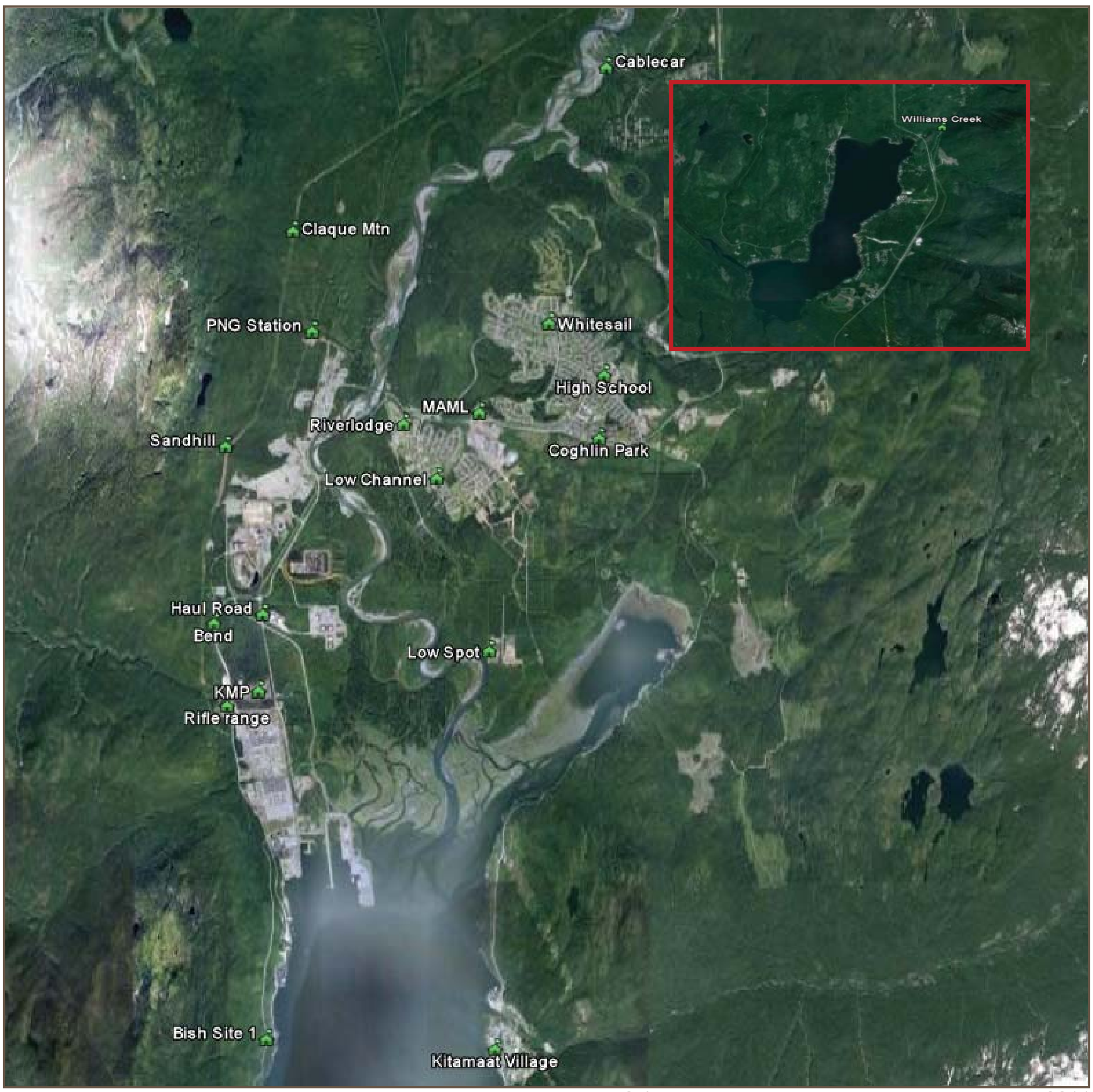


Figure 6.4 — Passive monitoring sampling locations, 2011


Western Helmock

Hemlock sampling, August 2011

Vegetation monitoring

Chapter 7

Introduction

The vegetation monitoring and assessment program consists of two parts: an annual collection of current year foliage of western hemlock, followed by an analysis of the concentration of fluoride and sulphur content in needle tissue; and, on a biennial basis, a survey of vegetation in the vicinity of Kitimat Operations to document the health and condition of vegetation. The annual collection has been conducted since 1970, giving B.C. Operations one of the largest historical databases of this type in British Columbia. The data provides long-term and comparable measures of fluoride and sulphur absorption in vegetation, both of which are found in emissions from Kitimat Operations.

The purpose of the monitoring and assessment program is to:

- Document the general growing conditions in the Kitimat area during the year of the inspection.
- Provide an assessment of the overall health of vegetation in the area, including documenting significant occurrences of insects and diseases.
- Document the concentration of fluoride and sulphur content in vegetation.
- Document the extent and severity of injury to vegetation associated with emissions (gaseous fluoride) from the Kitimat Operations.
- Provide early warning of changes in conditions.

In 2010 changes were made to the vegetation monitoring and assessment program based on Dr. John Laurence's (Plant Pathologist consultant) recommendations. The results of that investigation centered around the effectiveness of the monitoring program. Changes to the program were made in three areas:

- Changes to sample site locations.
- Standardization of sampling protocols.
- Increased quantitative assessment and documentation of the vegetation condition during biennial visual inspections.

Collection of western hemlock for foliar analysis is now conducted along directional transects away from the center of Kitimat Operations. The directional transects allows an estimation of the maximum concentrations of fluoride and sulphur in foliage as well as the reduction in deposition with distance from the Smelter. Sample harvesting is usually conducted at 37 sites at the end of the growing season by gathering the current year's growth. This is done because vegetation is more sensitive to fluoride and sulphur emissions in the spring, when new tissue is tender and growing rapidly. The sampling program focuses on hemlock because it is evenly distributed throughout the valley and is a reliable indicator for vegetative absorption of emissions. This year's samples were collected by an independent consultant and analyzed at Rio Tinto Alcan's Vaudreuil Analytical Laboratory in Quebec.

One of the significant improvements made to the sampling methodology is to conduct the sample collection in a short time frame. In 2011, one more site was added to the usual 37 sites bringing the total number of sampling sites to 38. All 38 samples were collected in under one week. They were then refrigerated in their collection bags until processing. Field sampling occurred between August 14 and 19.

The data reflects results from sites which have been consistently monitored since the inception of this program, while the fluoride concentration map (page 7.4) was developed using only sites sampled in 2011.

In addition to annual vegetation sampling, the multi-media permit also requires that a qualitative assessment of vegetation condition in the Kitimat valley be conducted by an external expert every second year. The next biennial inspection is scheduled for the 2012 sampling season.

2011 Monitoring results

Fluoride content

There is a strong correlation between fluoride concentrations in hemlock and fluoride emissions from the potroom roofs at Kitimat Operations. The reduction of gaseous fluoride emissions in addition to high levels of precipitation in 2011 was reflected in significantly lower concentrations in vegetation. In 2011, fluoride concentration in hemlock samples averaged 15 ppm, compared to 40 ppm in 2010 **(Figure 7.1)**. This is a decrease of 62.5 per cent compared to 2010 and a decrease of 72.2 per cent from the 2009 average of 54 ppm. However, because the sample site locations changed in 2010, these averages may not be directly comparable.

On a monthly basis, gaseous fluoride emissions from Kitimat Operations were higher during the 2011 growing season (refer to Chapter 11). There were no non-compliances relative to the gaseous fluoride emissions in 2011 **(Figure 7.2).**

The fluoride concentration map (page 7.4) shows the geographic distribution of accumulated fluoride in hemlock throughout the study area. This map shows the expected range of accumulated fluoride levels at and between sample plots with color-coded concentration ranges.

Figure 7.1 — Long-term performance, hemlock fluoride content & gaseous fluoride emissions, potroom roofs

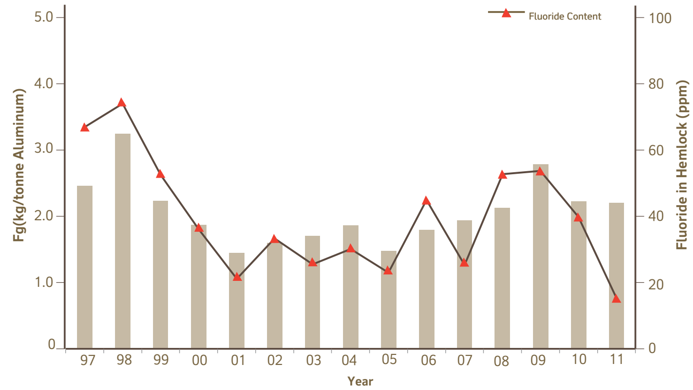


Figure 7.2 — Gaseous fluoride loading, potroom roofs, 2011

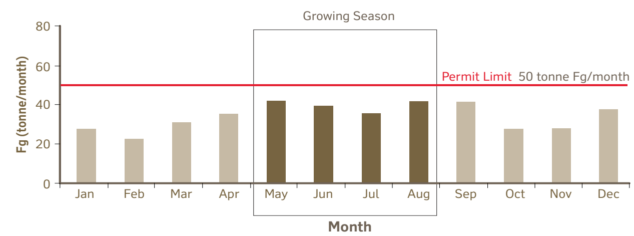
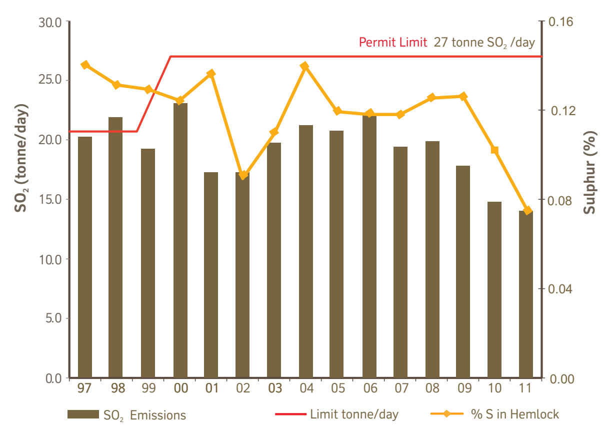


Figure 7.3 — Long-term performance, hemlock sulphur content & SO_2 emissions, entire smelter



Fluoride impact: discolouration and curling of leaves

2011 results show that higher concentrations of fluoride in hemlock foliage continue to be measured in collections from sites nearest Kitimat Operations. However, the significantly elevated concentrations are restricted to the west side of Minette Bay and the area from Hospital Beach to the Service Centre.

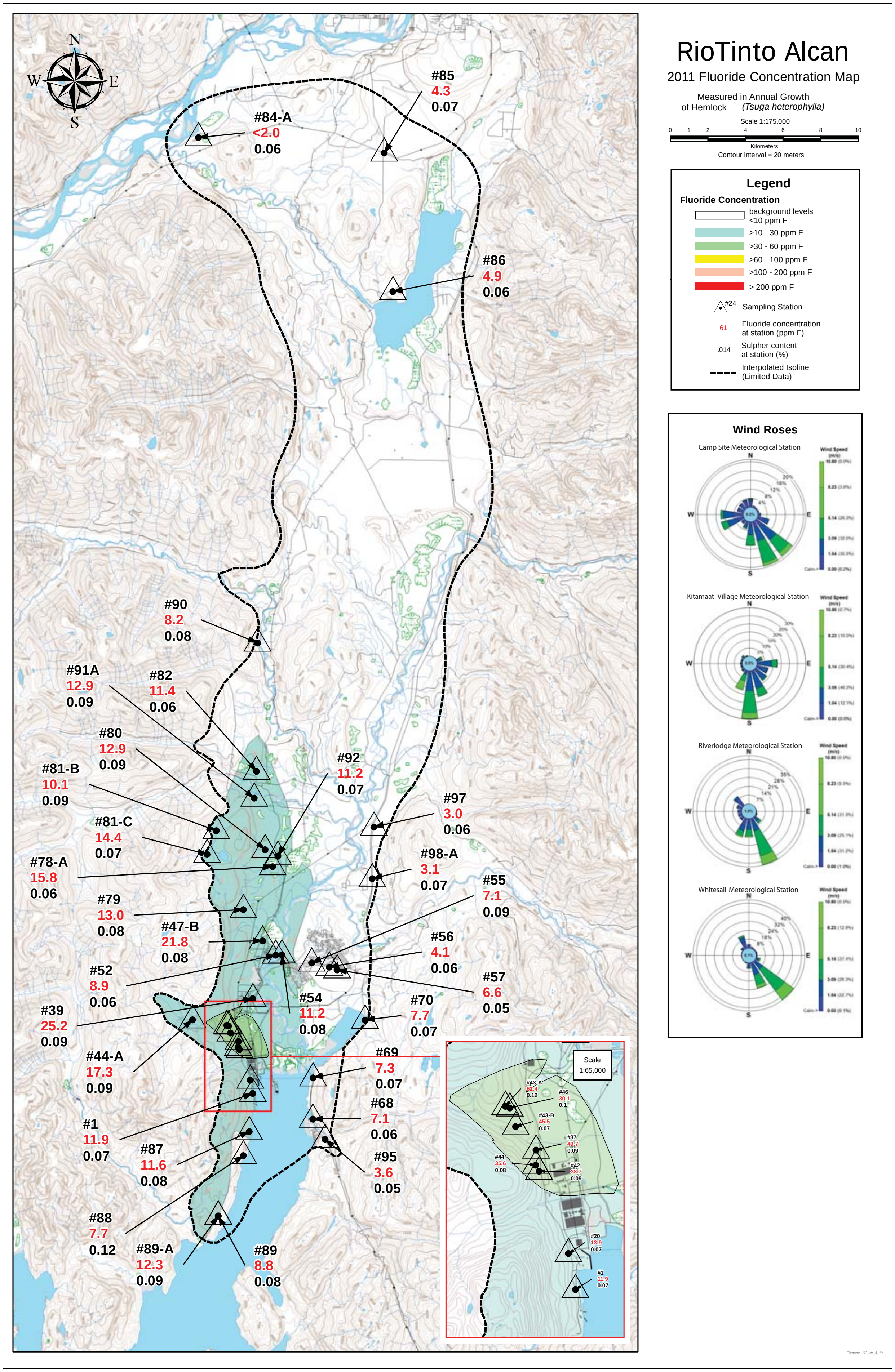
Sulphur content

Vegetation can absorb higher concentrations of suphur than flouride before visual damage can be detected. Annual averages of sulphur concentrations in vegetation in the Kitimat-Terrace area have remained relatively uniform, with little variance across the sample area and have rarely been found above background levels.

The average sulphur concentration in hemlock for 2011 was 0.08 per cent which was a slight decrease from the 2010 value of 0.10 per cent **(Figure 7.3)**. Sulphur content in vegetation within this region is much lower than that found in hemlock under similar climatic and topographic conditions elsewhere in B.C. and it is not considered a significant pollutant. ❖

Hemlock sampling

2011 Fluoride Concentration Map



South landfill

Waste management

Chapter 8

Introduction

The operation of the smelter results in the generation of various solid and liquid wastes. In August 2010, the multimedia permit was amended to allow for the disposal of KMP non-hazardous related wastes into the south landfill. The amendment is inclusive of the design, operation and closure phases. The appropriate procedures for handling, storage and disposal of these wastes are in place and are reviewed as changes in operations occur.

Waste management procedures ensure full compliance with requirements related to regulated hazardous wastes and additional materials deemed to be hazardous by B.C. Operations.

Opportunities for waste reduction and for improvements in waste handling are assessed and implemented on a continuous basis. In particular, opportunities to recover, reuse, and recycle waste materials are pursued whenever feasible. On-going practices include reducing raw material usage, thus reducing demand on the landfill and contributing to reducing the overall impact on the environment.

Waste management activities are tracked and reported. Only inert and asbestos waste volumes and monthly wood waste burn volumes require monitoring in compliance with a permit limit.

2011 Performance

Spent potlining

Spent potlining (SPL) is one of the most significant hazardous waste materials produced at Kitimat Operations, and its disposal presents a challenge throughout the aluminum industry.

Alternative treatment and disposal options continue to be investigated, while efforts to increase potlining lifespan (and thereby reduce SPL generation) continue.

During 2011, a total of 19,215 tonne of SPL was shipped off-site for treatment and permanent disposal in a secure landfill compared to the 6,226 tonne in 2010. The increased volumes are associated with the closure of lines 7 and 8.

Asbestos and refractory ceramic fibres (RCF)

Asbestos and refractory ceramic fibres (a less hazardous substitute) are used for insulation. These materials are considered by Kitimat Operations to be sufficiently hazardous to require special disposal methods. The asbestos and ceramic fibres are sealed in specifically designed plastic bags and buried in the north landfill on the smelter site (refer to Kitimat Operations map on page 2.3 for waste storage, disposal and managed sites).

In 2011, a total of 108 bags of this material were buried, totalling 3.0 m^3 (**Figure 8.1**).

Waste sludge

Grease and paint sludge are collected and sent off-site for environmentally safe disposal. Grease sludge is generated from the use of grease in various mechanical applications, while paint sludge may consist of leftover paint or wastes such as solvents used to clean paint brushes. Volumes of both wastes fluctuate depending on the levels of particular activities at the smelter site in any given year. In 2011, the grease sludge volume was 1,025 litres and the paint sludge volume was 4,100 litres (**Figure 8.2**).

Wood waste

Wood waste is collected from around the smelter site on a regular basis and sent to a wood containment area adjacent to Kitimat Operations south landfill.

Wood is burned once sufficient volumes have accumulated at the containment area. Six burns were conducted in 2011, in January, April, May, July, August and October. As of August 2011, a permit amendment allows for the burning of up to 960 m^3 per month, and there were no exceedances of this limit in 2011. A total of 3,360 m^3 (1,680 tonne) of wood waste was burned during the year (**Figure 8.3**).

Tires

Two main types of tires are used at Kitimat Operations: solid rubber tires in areas where there may be contact with molten metal, and pneumatic tires elsewhere. Although tests have been conducted, no recycling option has been identified for solid tires and they are disposed of at the Kitimat south landfill. All used pneumatic tires are sent to a local company which recycles 90 per cent (materials chipped for other uses) and 10 per cent are re-treaded for reuse as tires. A total of 557 tires (314 solid and 243 pneumatic) were disposed of or sent for recycling in 2011 (**Figure 8.4**).

Figure 8.1 — Long-term disposal, Asbestos & RCF disposal

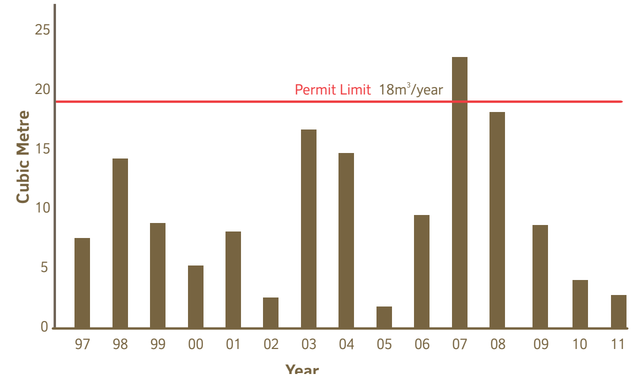


Figure 8.2 — Long-term collection, waste sludge collection

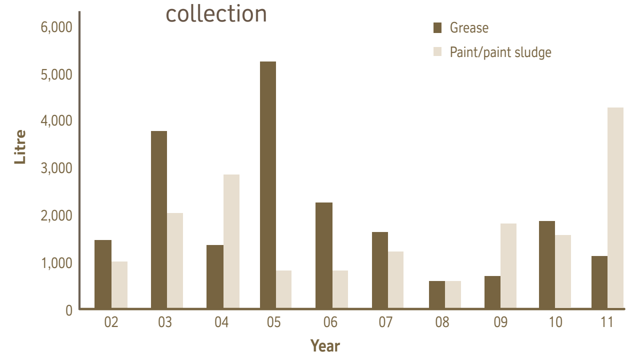


Figure 8.3 — Long-term, Wood waste burns, 2011

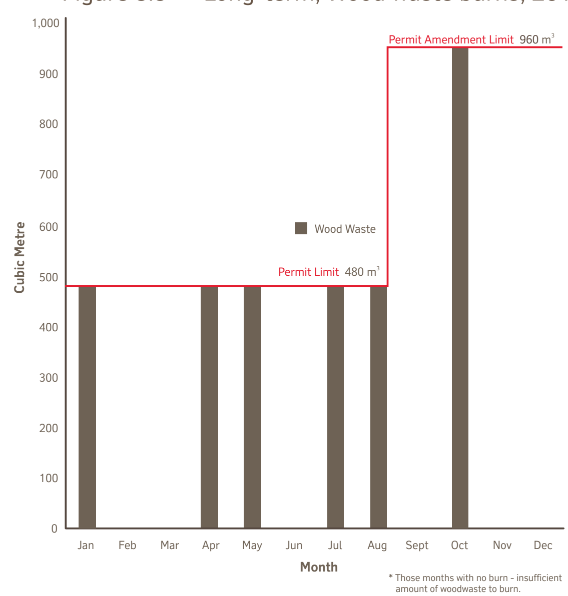


Figure 8.4 — Long-term disposed or recycled, tires

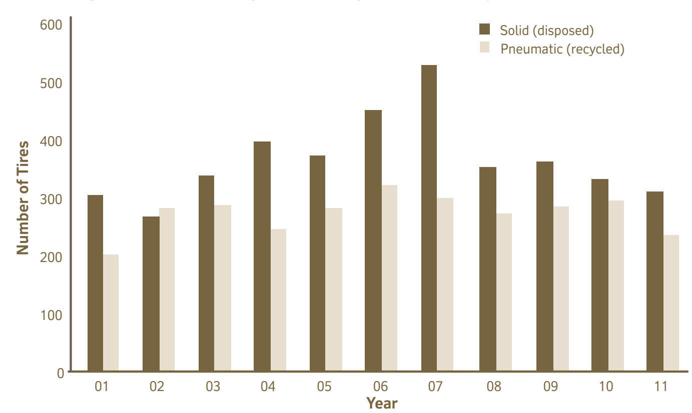


Figure 8.5 — Long-term oil recovery, oily water

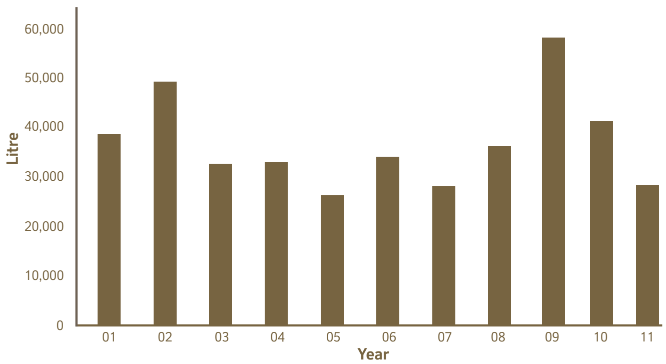


Figure 8.6 — Long-term recycling, paper & cardboard

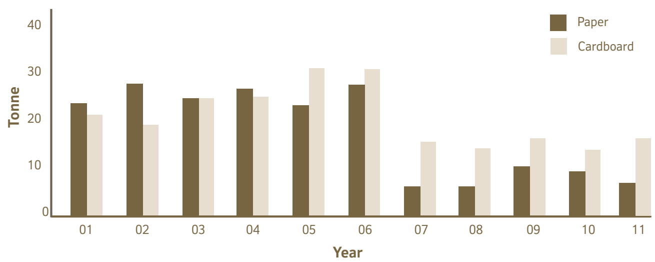


Figure 8.7 — Long-term recovered or recycled, waste liquids

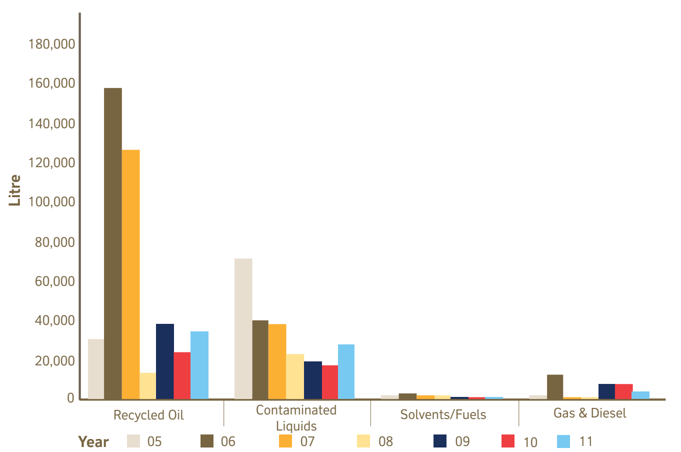
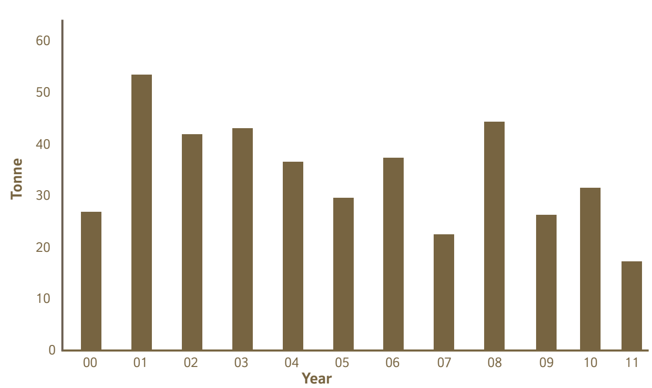


Figure 8.8 —Long-term recycling, lead acid batteries



Oily water

During the normal course of operations, oil-based materials can become contaminated with water (primarily rain water). These materials are collected and sent to a waste handler in Prince George that recovers the oil. Volumes collected for recovery decreased last year, with a total of 28,290 litres sent for recovery in 2011 (**Figure 8.5**).

Paper & cardboard

Both paper and cardboard are collected and shipped to a local facility for recycling. In 2011, 7.2 tonne of paper and 13.5 tonne of cardboard were shipped for recycling (**Figure 8.6**).

Waste liquids

A variety of categories of waste liquids (used or contaminated) are routinely collected and sent to facilities in Prince George for either recovery or recycling into other products. Volumes of these materials fluctuate depending on the levels of particular activities at Kitimat Operations in any given year (**Figure 8.7**).

Lead acid batteries

Used lead acid batteries are sent to a facility in Ontario where they are broken down into their constituent parts for recycling. The number sent for recycling varies depending on the number of batteries that reach the end of their lifespan in any given year. A total of 17.1 tonne of lead batteries were sent for recycling in 2011 (**Figure 8.8**).

Lamps

Used fluorescent and high-intensity lamps are sent to facilities, mainly located in Ontario, where they are broken down into their constituent parts for recycling. This ensures appropriate disposal of mercury and other heavy metals found in these types of lamps. A total of 8,444 lamps were sent for recycling in 2011 (**Figure 8.9**).

Oil filters

Used oil filters are sent to facilities in Alberta where they are broken down into their constituent parts for recycling. Prior to shipping, filters are first drained and crushed on-site. A total of 17.1 tonne of filters were sent for recycling in 2011 (**Figure 8.10**).

Landfill management

The south landfill is the main landfill for smelter operations. It has been operational since the plant opened and is expected to be open for eight years after the KMP is complete. Management of landfill operations for 2011 was split into two phases: the pre KMP phase (January to August) and the KMP operational phase (August to December).

Incoming waste streams included: industrial waste, putrescible waste, contaminated soils, asphalt and asbestos contaminated materials which include soil and concrete. These waste categories were used to track incoming waste streams versus original volume projections. The waste streams are only accurate for July to December. Prior to this time, the waste volumes were not tracked by waste stream categorization system.

The total volume of the landfill during the pre KMP phase was 636,410 m^3 and the total volume of KMP related wastes for the operational phase was 54,374 m^3.

Miscellaneous process waste

In addition to the special disposal and recycling initiatives described above, various types of miscellaneous process wastes are shipped off-site. A variety of processing and disposal methods are employed to deal with the miscellaneous process waste (**Table 8.1**).

Figure 8.9 — Long-term recycled, lamps

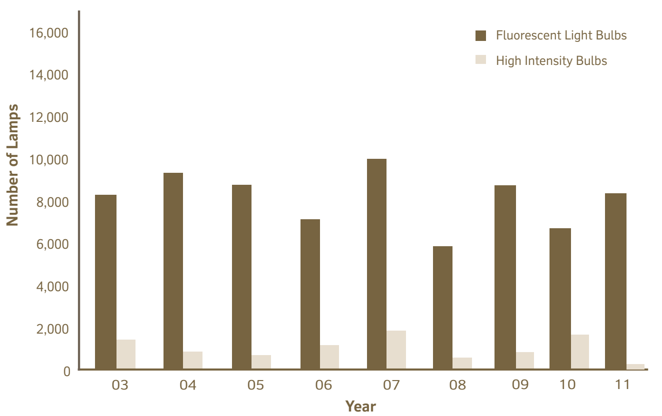


Figure 8.10 — Long-term recycled, oil filters

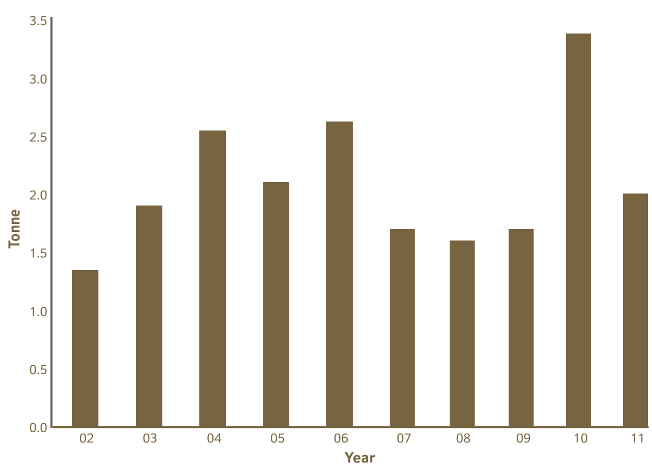


Table 8.1 — Miscellaneous process waste, 2011

Process waste	Tonne shipped *	Destination
Steel scrap	3,691.6	Sold as scrap metal
Aluminum pot pads	2,517.6	U.S. recycling company
Anode carbon	411.1	Canadian disposal company
Duct scraping	251.2	U.S. disposal company
Aluminum saw chips	122.3	U.S. recycling company
Studblast fines	240.5	Canadian disposal company
Carbon dust (side millings)	0	Canadian disposal company
Electrical wire (insulated)	6	Sold as scrap metal
Crucible lining	34.1	Canadian disposal company
Aluminum (miscellaneous)	138.0	Sold as scrap metal
Pitch cones/fines	208.9	Canadian disposal company
Steam cleaning sludge	13,000	Canadian disposal company
Air filters	17.2	Canadian disposal company
Stainless steel	28.2	Sold as scrap metal
Sodium hydroxide solution	2,255 L	Canadian disposal company
Brass/copper	1.7	Sold as scrap metal
Aluminum smelting residue, inert	2,685.5	U.S. disposal company

* All values are in tonne unless otherwise noted.

South landfill aerial

Groundwater wellsite at the spent potlining landfill

Groundwater monitoring

Chapter 9

Introduction

A variety of monitoring programs are conducted relating to groundwater quality and flow in the vicinity of Kitimat Operations' landfill sites that are, or have the potential to be, a source of contamination. In 2011, these efforts focused on the spent potlining landfill and the dredgeate short-term storage cells. Long-term initiatives are underway with objectives to further reduce groundwater contamination and identify disposal and treatment options for stored materials.

2011 Monitoring results

Spent potlining landfill

The spent potlining landfill is comprised of three separate subsections formerly used to dispose of spent potlining (SPL). The landfill is located south of Potroom 1A and north of the Anode Paste Plant (refer to **Kitimat Operations map effluent and waste management system** on page 2.3).

Up to 1989, approximately 460,000 m^3 of (SPL) was disposed of at the landfill site as per permit limits. The landfill was decommissioned in the fall of 1989 and initially capped with a low permeability cover. Over the next decade the three subsections were capped with PVC liners. The capping significantly reduced surface water infiltration, thus reducing contaminant loading into the environment.

Between 1989 and 2004, SPL was stored in Buildings 504 and 550 prior to disposal in a secure landfill. Since 2005, all of the SPL material generated on-site has been transferred to specially designed containers and shipped off-site for disposal.

Groundwater monitoring has been carried out in accordance with the requirements of the multi-media permit and the Technical Assessment Report submitted to and accepted by the Ministry early in 2004. The Technical Assessment Report presented an improved monitoring method and loading calculation procedure based on an extensive and calibrated groundwater flow model.

In 2007, 20 pressure transducers and one barologger were installed in selected groundwater wells to continuously measure water levels. Pressure transducers were utilized to increase the precision of the water level measurements used for the volumetric flux calculations. Pressure transducer data were downloaded four times in 2010.

A groundwater sampling campaign was completed in September 2011. The sampling campaign included collection of geochemistry parameters and analytical sampling on selected groundwater monitoring wells. Water level monitoring is conducted along three main transects: the Near-Shore Fence, the Near-Landfill Fence and the Main Transect east of the Anode Paste Plant. Groundwater was analyzed for the following parameters: dissolved fluoride, cyanide (SAD – strong acid dissociable), dissolved metals, dissolved oxygen, electrical conductivity, temperature, redox potential and acidity.

Since 1998, contaminant concentrations of dissolved fluoride have gradually declined **(Figure 9.1).** The Main Transect best demonstrates the monitoring results for all three transects. An extensive report is sent annually to the Ministry which documents and interprets the results.

Reported estimates of contaminant loading in the Douglas Channel marine environment from the SPL Landfill in 2011 were comparable to previous years for cyanide and aluminum but slightly higher for fluoride. In 2011, fluoride, cyanide and aluminum loadings were estimated to be 28,361 kg, 330 kg, and 566 kg respectively. The observed increase in loading for fluoride is a consequence of the higher volumetric flux of groundwater in 2011.

Dredgeate cells and SPL overburden cell

In November 1995, approximately 2,000 m^3 of ocean sediment was dredged from the wharf berthing area and placed in two lined storage cells located north of Anderson Creek. This sediment was removed during a normal dredging operation and required special disposal because of the presence of polycyclic aromatic hydrocarbons in the form of solid pitch ('pencil pitch'). Kitimat Operations no longer receives pitch in this form. On-going upgrading and maintenance of these cells continues with one liner replaced in 2003, and the other upgraded in 2004.

Three wells are utilized to specifically monitor groundwater in the area surrounding these containment cells. They are referred to as KL-1, KL-2 and KL-3 and are located to the west, south and east of the cells respectively. Groundwater sampling was conducted on a quarterly basis in 2011. The samples were analyzed for dissolved fluoride and dissolved aluminum. The 2011 contaminant monitoring results are consistent with historical trends and are well within the expected seasonal variation **(Figure 9.2)**.

The SPL overburden cell is located west of the wharf dredgeate cells. The cell is comprised of Claymax liner from the eastern portion of the SPL Landfill. Both the wharf dredgeate cells and SPL overburden cell have a double membrane lining system that collects water between the primary and the secondary liners. This water is tested and pumped out on a regular basis. In 2011 approximately 271,530 litres was pumped from the six sumps. ❖

Figure 9.1 — Long-term concentrations, dissolved fluoride, Main Transect

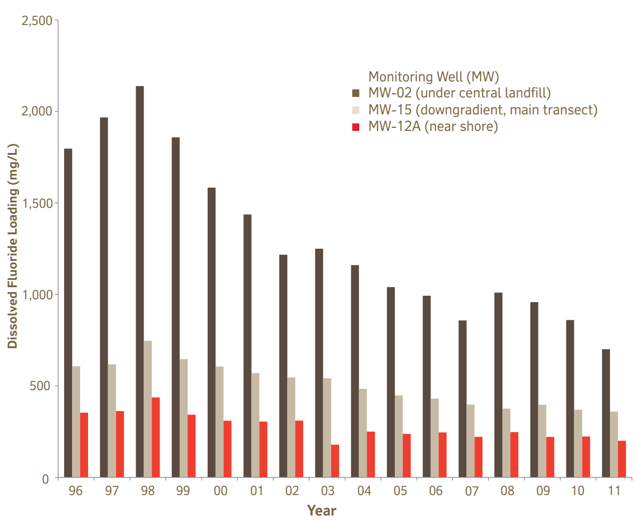
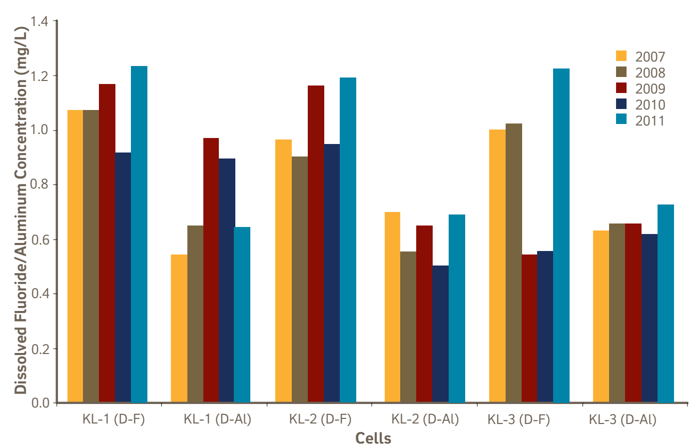


Figure 9.2 — Long-term concentrations, dissolved fluoride & aluminum, Dredgeate Monitoring Cells



Kemano River

Kemano permits

Chapter 10

Introduction

BC Operations Kemano facility is the hydroelectric power station that supplies electricity to Kitimat Operations. Up until 2000, Kemano Operations included a townsite with a resident population of 200 to 250 people. At that time the powerhouse was automated which reduced the operations and maintenance personnel to rotating crews of 20 to 30 people.

In 2011 project work was conducted on-site. The number of individuals at the Kemano camp site increased during the months of June and July and additional workers were added in August and September. Even with increased generation and discharges associated with the increased population, performance indicators for this location were well below permit limits.

2011 Performance

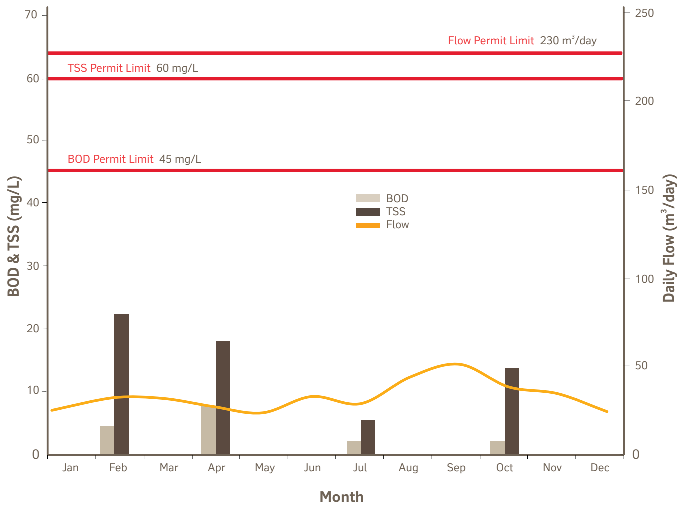
Kemano effluent discharge

The Kemano sewage treatment plant and several septic tanks in the area surrounding Kemano have effluent discharge permits. The discharges consist of treated sewage and are subject to permit requirements with respect to biochemical oxygen demand (BOD) levels and concentrations of total suspended solids (TSS). BOD is an indirect measure of the concentration of biodegradable matter, while TSS is a direct measure of suspended solids.

Prior to 2006, effluent results were analyzed monthly to establish a baseline. Since then, the permit requires only quarterly sampling. The quarterly results are similar to the historical monthly results. All measurements of Kemano effluent discharge were below permit limits in 2011 **(Figure 10.1)**.

Kemano River side channel

Figure 10.1 — Kemano effluent discharge, 2011



Kemano emission discharge

An incinerator is used to burn municipal-type waste generated by rotating crews while residing at Kemano Operations. The incinerator is a double-chambered, fuel-fired, forced air unit. The permit requires that the exhaust temperature of the incinerator remain above 980°C and in 2011 permit requirements were maintained.

Kemano landfill

Non-combustible refuse and ash from the incinerator is buried in a landfill near Kemano. The landfill permit limits the amount of material to an annual maximum of 300 m³. In 2011, 16.40 m³ of refuse was buried.

Treated sludge from the sewage treatment plant, septic tanks and biological containers are also deposited in the same landfill. Filtration ponds are used to de-water the sludge before disposal. The permit allows for disposal of up to 900 m³ of treated sludge per year. In 2011, 73.4 m³ of sludge was disposed.

Seekwyakin Camp effluent discharge

Seekwyakin Construction Camp, located three kilometres north of Kemano, was historically used by West Fraser Timber Co. Ltd. and B.C. Operations. Effluent sewage discharges from the camp require a permit when the camp has more than 25 residents. In 2011, Seekwyakin Camp saw very little activity and usage remained well below 25 residents. ❖

Lifting equipment into camp

Kemano River estuary

Kitimat Operations overview

Summary of non-compliance and spills

Chapter 11

2011 Performance

Non-compliance summary

In 2011, there were a total of 9 non-compliances. These non-compliances are summarized with a brief description of their causes and corrective actions that are either being assessed or implemented at the time this report was prepared **(Table 11.1)**. Six of the non-compliances were related to effluent discharge and four of these non-compliances were related to a heavy rain on snow event in January.

Spill summary

Spills at Kitimat Operations are first reported to the Plant Protection Department and subsequently to the Environmental Services Department. Regulatory requirements are in place to report certain types of spills to the Ministry of Environment (referred to as "reportable" spills), depending on the nature and volume of the substance spilled. In 2011, 10 spills were reported to the Ministry (**Table 11.2**).

Spill-related awareness and prevention is a major focal point throughout Kitimat Operations. Immediate containment and minimization of potential environmental damage is the first priority. Specially equipped response teams are available when required. If appropriate, other agencies are informed and their cooperation enlisted.

Root cause analysis of reportable spills is conducted to prevent recurrence, and a system is maintained for recording and reviewing all spills and their frequency by type. This ensures that appropriate corrective actions are identified and tracked through to completion.

No known environmental damage was associated with any of the spills reported during 2011.

Table 11.1 — 2011 Summary of non-compliance

	Occurrence	Type	Magnitude	Location	Causes	Corrective actions
Emissions	August	Total Particulate	8.4 kg/tonne Al	Potroom Roofs	Actions on sick pots were not attended to immediately.	Track sick pots on Lean Level 2 and take actions.
	6 September	Pitch fume release	3 successive short bursts	Pitch Incinerator	Gas valve actuator failure.	Incinerator set to high manual operation and valve repaired.
Effluents	27 January	Toxicity failure at F-Lagoon Dissolved aluminum at F-Lagoon Dissolved fluoride at F-Lagoon	Did not pass Permit Limit: Pass/Fail 3.91 mg/L Permit Limit: 1.0 mg/L 10.3 mg/L Permit Limit: 10 mg/L	F-Lagoon	Basement material from the clean up of Lines 7&8 washed into F-Lagoon during rain on snow event.	Black belt project initiated to understand and discover the best way to remove the basement material.
	27 January	Overflow at B-Lagoon	Permit Limit: 210,000 m³/d	B-Lagoon	Rain on snow event resulting in significant volume of water in the lagoons.	Root cause unknown. Recommendation by Ministry and RTA to amend P2 Permit to authorize overflow events under high precipitation events.
	8 August	Failure to collect effluent daily sample	Identified in Section 8.2.2 of the P2-0001 multi-media permit	B-Lagoon	The B-Lagoon ISCO Sampler was not able to collect a composite sample August 8, 2011 because the program had stopped as a result of a low battery error.	Sampler was repaired.
	23 September	Failure to provide accurate data	Identified in Section 3.1.2 of the P2-0001 multi-media permit	B-Lagoon	Abnormal data for the B-Lagoon flume flow gauge recorded for four hours.	Investigation into the malfunction of the equipment was completed.
Waste	8 August	Failure to prevent a bear from accessing garbage.	Identified in Section 5.1.7 of the P2-0001 multi-media permit	Landfill	Bear was able to enter the landfill through an open gate.	Inspections done to check that the electric fence is in good operating condition and that the access gate remains locked unless vehicles are passing. Landfill operating plan ensures a prompt coverage of waste.

Table 11.2 — 2011 Summary of reportable spills

Occurrence	Substance	Amount	Environmental Media	Causes	Corrective actions
24 February	Teresso 46 Oil	80 L	Fresh water	The internal oil cooler of generator #8 cracked and leaked water into the bearing pot displacing oil into the tailrace. The alarm malfunctioned prompting no warning.	The generator was immediately shut down and the alarm was repaired.
11 March	Supply process water	60 L/min	Fresh water	Leak in pipe. Approximate time of the leak was 12 hours.	The leak was stopped and then a project was initiated to repair the pipe.
13 March	Supply process water	600 m^3	Fresh water and gravel	Ruptured pipe	Pipe shut off to the line. Consulting company called to conduct an ecological assessment. Pipe repaired and creek bed restored.
31 March	Teresso 46 Oil	30 L	Fresh water	Turbine cooler for Generator #8 leaked. Put in a temporary cooler but have added oil since. The leak is ongoing from drain of existing cooler.	Final repair completed. Upon further investigation, all oil accounted for. No oil entered the receiving environment.
20 May	Potable water	238.45 m^3	Soil, gravel, fresh water, marine	Pipe ruptured at freshly repaired joint.	Water supply turned off permanently.
30 May	Oil	Unknown	Marine	An oily substance was discovered floating west of the RTA wharf.	Assessment completed with shore, land and aerial inspection. Western Canada Marine Response attended for additional water-side assessment. Consulting company attended for shore assessment.
23 November	Diesel	Unknown	Marine	Unknown source.	Coast guard called. Sensitive areas inspected for signs of impact.
2 December	Transformer Oil	5 m^3	Asphalt and gravel	Equipment operator moved a piece of scrap metal with back hoe. The operator struck a transformer causing transformer oil to leak.	A berm was put in place to contain water/snow in the south courtyard area. Staff worked to stop the leak and capture the remaining transformer oil. Contracting company made an assessment of the clean up.
6 December	Canola Oil	200 L	Gravel	Unknown	Clean up completed.
7 December	Hydraulic fluid	120 L	Soil	Leak from an excavator at South Landfill	Spill contained by digging a berm and applying absorbent pads.

Bald eagles, Kitimat estuary

Glossary

Chapter 12

Anode
One of two electrodes (the positive electrode) required to carry an electric current into the molten bath, a key component of the electrolytic reduction process that transforms alumina ore into aluminum.

Anode effects
A chemical reaction that occurs when the level of alumina in a pot falls below a critical level, resulting in reduced aluminum production and the generation of perfluorocarbons (PFC) – a variety of gases with a high carbon dioxide equivalency.

Anode paste
One of the materials used to manufacture anodes, composed of calcined coke and pitch.

Attrition index
A measurement scale used to indicate alumina strength: the higher the value, the weaker the alumina.

Carbon dioxide (CO_2) equivalency
A measure of greenhouse gas output, based on the conversion of a given emission into a volume of CO_2 with an equivalent environmental impact.

Carbon out
Removal of chunks of carbon that have fallen off the anode or have formed points on one part of the anode.

Cassette
A sampling procedure for air emissions where contaminants are collected using filters placed at regular intervals along the length of a potroom.

Cathode
One of two electrodes (the negative electrode) required to carry an electric current into the molten bath; a key component of the electrolytic reduction process that transforms alumina ore into aluminum.

Coke calcination/calcined coke
A process involving the use of high temperatures to drive off volatile matter found in green coke, thus producing calcined coke for use in anode manufacturing.

Composite sample
A composite sample is representative recorded over a fixed period of time, such as 24 hours, and is taken at a defined frequency. For example, all effluent composite samples are taken over 24 hours during which a 50 mL sample is collected every 10 minutes.

Dredgeate
Any material removed by dredging.

Dry scrubber
Pollution control equipment used to remove contaminants (in gaseous or particulate forms) from air emissions.

Effluent
Water discharge flowing out of the B-Lagoon outfall after treatment in the B-Lagoon system.

Electrolyte
A chemical compound that provides an electrically conductive medium when dissolved or molten.

Electrolytic reduction
This process uses electricity to remove oxygen molecules from aluminum oxide to form aluminum metal.

Exception pot
A pot that is not operating within the normal range and could result in openings in the alumina sealing. A reliable indicator of increased fluoride emissions.

Fugitive dust
Solid airborne particulate matter that is emitted from any source other than a stack or a chimney.

Geomean
A geomean is one of three methods used to average a product of numbers. The geomean is a statistical measure that factors out values that are unusually large or small (called outliers) before calculating the average or mean. This provides a more representative result by eliminating outliers that may skew the average value and obscure trends that may otherwise emerge.

Green coke
The raw form of coke received at Kitimat Operations, which is calcined for use in the manufacture of anodes; a by-product of oil refining.

Grab sample
A grab sample is used to collect information on the process (i.e. effluent) for a specific or a short time. Variability of this data is much higher than a composite sample.

Leachate
A liquid which results from water collecting contaminants as it passes through waste material.

Leftover metal
Metal which accumulates in a pot when the schedule to remove the metal is not followed.

Loading
A method of measuring gaseous fluoride. Effective December 2007, a new permit limit was set by B.C. Ministry of Environment at 50 tonne of gaseous fluoride loading per month and replaces the 'rate' measurement of gaseous fluoride per tonne of aluminum.

Low magnitude pot
An exception pot which has had an anode effect with a magnitude of 25 volts or less.

Maximum allowable level
This level provides adequate protection against pollution effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.

Maximum desirable level
This level is the long-term goal for air quality programs and provides a basis for the federal government's anti-degradation policy for unpolluted parts of the country.

Maximum tolerable level
This level denotes time-based concentrations of air contaminants beyond which appropriate action is required to protect the health of the general population.

Ministry
The British Columbia Ministry of Environment; to which B.C. Operations reports on compliance with its permit requirements.

Off-light pot
Pots which have gone for a long period of time (generally 40 hours) without an anode effect.

Piezometer
A small diameter water well used to measure the hydraulic head of groundwater in aquifers.

Pitch
One of the materials from which anodes are made, and a by-product of metallurgical coke production.

Polycyclic Aromatic Hydrocarbons (PAH)
A group of aromatic hydrocarbons containing three or more closed hydrocarbon rings. Certain PAH are animal and/or human carcinogens.

Pots/potrooms
Pots are large, specially designed steel structures within which electrolytic reduction takes place. The 588 pots at Kitimat Operations are housed within 10 potroom buildings.

Process correction
Accessing the condition of exception or sick pots and bringing them back to normal operating conditions.

Putrescible Waste
Waste that rots can be easily broken down by bacteria, for example food and vegetable waste.

Pyroscrubber
A combustion-based system that controls dust emissions from the coke calciner.

Retention time
The average time a drop of water takes to move through a lagoon from inlet to outlet.

Scow grid
A dry dock for flat bottomed vessels (scows) formed from a series of piles and sills.

Sick pot
A pot that has an elevated bath temperature and cannot be sealed properly or is uncovered.

Spent potlining
Lining from the inside of pots, composed of refractory bricks and carbon, that has deteriorated to the point where it needs to be replaced.

Stud
A stud is constructed of steel. Metal studs are inserted vertically into the anode to conduct the flow of electricity through the anode and into the electrolyte.

Total Suspended Solids (TSS)
A water quality measurement that refers to the dry weight of particles trapped by a filter, typically of a specified pore size. This parameter was at one time called Non-Filterable Residue (NFR).

Weir
A device to measure, retain or regulate water flow.

Electronic version available at:
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March 2012